FAA-G-2100e
March 11, 1987

U.S. Department of Transportation

Federal Aviation Administration

Specification

ELECTRONIC EQUIPMENT, GENERAL REQUIREMENTS

A-W(ES/PM/AP/ST/LG/PO)-3; A-X(AF)-3; A-Z-3

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the requirements in MIL-STD-454, each update of MIL-STD-454 will be reviewed and the applicable changes incorporated into FAA-G-2100.

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List of Tables

tests for ground electronic equipment. The individual equipment specifications identify those requirements of this specification that are applicable.

2. APPLICABLE DOCUMENTS

2.1 Government documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

SPECIFICATIONS:

Federal

F-F-310	Filter, Air Conditioning: Viscous-Impingement and Dry Media, Replaceable
QQ-S-365	Silver Plating, Electrodeposited: General Requirements for
W-C-375	Circuit Breakers, Molded Case; Branch Circuit and Service
QQ-P-416	Plating, Cadmium (Electrodeposited)
QQ-S-571	Solder, Tin Alloy: Tin Lead Alloy; and Lead Alloy
J-C-580	Cord, Electrical and Wire, Electrical (0 to 600 Volt Service)
W-C-596	Connector, Plug, Receptacle and Cable Outlet, Electrical Power
W-C-596/12	Connector, Receptacle, Electrical, General Purpose, Duplex, Hospital Grade Grounding, 2 Pole, 3 wire, 15 Amperes, 125 Volts, 50/60 Hertz
W-C-596/13	Connector, Plug, Electrical, General Purpose, Hospital Grade Grounding, 2 Pole, 3 Wire, 15 Amperes, 125 Volts, 50/60 Hertz
W-C-596/75	Connector, Plug, Electrical, Midget Locking, Specific Purpose, General Grade, Grounding, 2 Pole, 3 wire, 15 Amperes, 125 Volts, 50/60 Hertz

	Lead Free General Purpose

FAA

FAA-G-1210	Provisioning Technical Documentation
FAA-C-1217	Electrical Work, Interior

Military

MIL-T-27	Transformers and Inductors (Audio, Power, and High Power Pulse), General Specification for
MIL-S-61	Shunts, Instrument, External, 50 Millivolt (Lightweight Type)
MIL-T-152	Treatment, Moisture and Fungus-Resistant, of Communications, Electronic, and Associated Electrical Equipment
MIL-V-173	Varnish, Moisture and Fungus Resistant (for Treatment of Communications, Electronic, and Associated Equipment)
MIL-J-641	Jacks, Telephone, General Specification for
MIL-P-642	Plugs, Telephone, and Accessory Screws, General Specification for
MIL-G-1149	Gasket Materials, Synthetic Rubber, 50 and 65 Durometer Hardness
MIL-I-1361	Instrument Auxiliaries, Electrical Measuring; Shunts, Resistors, and Transformers
MIL-S-3644,	Shaft Assembly, Flexible
MIL-L-3661	Lampholders, Indicator Lights, Indicator-Light Housings, and Indicator-Light Lenses, General Specification for
MIL-G-3787	Glass, Laminated, Flat; (Except Aircraft)
MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-C-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-W-6858	Welding, Resistance Spot and Seam
MIL-S-7742	Screw Threads, Standard, Optimum Selected Series; General Specification for

	Corrosion and Heat Resistant Alloys, Process for
MIL-S-8805/56	Switch Assemblies, Sensitive, Interlock, Unsealed
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter; General Specification for
MIL-W-8939	Welding, Resistance, Electronic Circuit Modules
MIL-C-10544	Connectors, Plug and Receptacle (Electrical, Audio, Waterproof, Ten Contact, Polarized)
MIL-T-10727	Tin Plating; Electrodeposited or Hot-dipped, for Ferrous and Nonferrous Metals
MIL-S-12285	Switches, Thermostatic
MIL-C-12520	Connectors, Plug and Receptacle (Electrical, Waterproof); and Accessories, General Specification for
MIL-S-12883	Sockets and Accessories for Plug-In Electronic Components General Specification for
MIL-P-13949	Plastic Sheet, Laminated, Metal Clad (For Printed Wiring Boards), General Specifications for
MIL-F-14256	Flux, Soldering, Liquid (Rosin Base)
MIL-P-15024	Plates, Tags and Bands for Identification of Equipment
MIL-C-15305	Coils, Fixed and Variable, Radio Frequency, General Specification for
MIL-F-15733	Filters and Capacitors, Radio Frequency Interference, General Specification for
MIL-S-15743	Switches, Rotary, Enclosed
MIL-F-16552	Filters, Air Environmental Control System, Cleanable, Impingement (High Velocity Type)
MIL-E-17555	Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts); Packaging of
MIL-W-18326	Welding of Magnesium Alloys, Gas and Arc, Manual and Machine Processes for
MIL-F-18327	Filters; High Pass, Low Pass, Band Pass, Band Suppression and Dual Functioning, General Specification for

	Non-established Reliability, General Specification for
MIL-T-21038	Transformers, Pulse, Low Power, General Specification for
MIL-S-21604	Switches, Rotary, Multipole and Selector; General Specification for
MIL-T-22361	Thread Compound; Antiseize, Zinc Dust-Petrolatum
MIL-S-22432	Servo motors, General Specification
MIL-S-22473	Sealing, Locking and Retaining Compounds: (Single-Component)
MIL-S-22820	Servomotor-Tachmeter Generator A.C. General Specification for
MIL-T-22821	Tachometer Generator A.C., General Specification for
MIL-B-23071	Blowers, Miniature for Cooling Electronic Equipment, General Specification for
MIL-T-23648	Thermistor (Thermally Sensitive Resistor), Insulated, General Specification for
MIL-D-23859	Delay Lines, Pulse, Electromagnetic, Fixed General Specifications for
MIL-N-25027	Nut, Self-Locking, 250 DEG. F, 450 DEG. F, 800 DEG. F
MIL-D-28728	Dial, Control, Multi-turn Counters General Specification for
MIL-R-28750	Relay, Solid State, General Specification for
MIL-R-28803	Readouts, Segmented, General Specification for
MIL-M-38510	Microcircuits, General Specification for
MIL-M-38527	Mounting Pads, Electrical-Electronic Component, General Specification for
MIL-C-39003	Capacitors, Fixed, Electrolytic (Solid Electrolyte), Tantalum, Established Reliability, General Specification for
MIL-C-39006	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, Established Reliability, General Specification for
MIL-C-39006/22	Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, (Polarized, Sintered Slug), 85 DEG C (Voltage Derated to 125 DEG C), Established Reliability, Style CLR79

MIL-W-46132	Welding, Fusion, Electron Beam, Process for
MIL-S-46163	Sealing, Lubricating, and Wicking Compounds: Thread-Locking, Anaerobic, Single Component
MIL-H-46855	Human Engineering Requirements for Military Systems, Equipment and Facilities
MIL-R-50781	Resolvers, Electrical, Linear: General Specification for
MIL-P-50884	Printed-Wiring, Flexible and Rigid-Flex
MIL-P-55110	Printed-Wiring Boards General Specification for
MIL-C-55116	Connectors; Miniature Audio, Five-Pin
MIL-T-55164	Terminal Boards Molded, Barrier, Screw and Stud Types, and Associated Accessories General Specification for
MIL-C-55181	Connectors, Plug and Receptacle, Intermediate Power (Electrical, Waterproof), Type MW, General Specification for
MIL-O-55310	Oscillators, Crystal, General Specification for
MIL-A-55339	Adapters, Connector, Coaxial, Radio Frequency, (Between Series and Within Series) General Specification for
MIL-R-55342	Resistors, Fixed, Film, Chip, Established Reliability General Specification for
MIL-F-55561	Foil, Copper, Cladding for Printed Wiring Boards
MIL-T-55631	Transformers; Intermediate Frequency, Radio Frequency and Discriminator, General Specification for
MIL-E-81512	Encoder, Shaft Position to Digital, Contact Type, Altitude Reporting, General Specification for
MIL-B-81744	Barrier Coating solution, Lubricant Migration Deterring
MIL-S-81963	Servo-Component, Precision Instrument, Rotating, Common Requirements and Tests, General Specification for
MIL-I-83446	Coils, Radio Frequency, Chip, Fixed or Variable, General Specification for
MIL-C-83503	Connectors, Electrical, Flat Cable, Non-environmental, General Specification for
MIL-T-83721	Transformers, Variable, Power, General Specification for

	Specification for
MIL-D-87157	Displays, Diode, Light Emitting, Solid State, General Specification for

STANDARDS:

Federal

FED-STD-H28	Screw-Thread Standards for Federal Services
FED-STD-151	Metals: Test Methods
FED-STD-406	Plastics: Methods of Testing

FAA

FAA-STD-001	Color and Texture of Finishes for National Airspace System Equipment
FAA-STD-012	Paint Systems for Equipment
FAA-STD-013	Quality Control Program Requirements
FAA-STD-016	Quality Control System Requirements
FAA-STD-020	Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment
FAA-STD-032	Design and Construction Standards for National Airspace System Support Facilities

Military

MIL-STD-22	Welded Joint Design
MIL-STD-188	Military Communication System Technical Standards
MIL-STD-198	Capacitors, Selection and Use of
MIL-STD-199	Resistors, Selection and Use of
MIL-STD-248	Welding and Brazing Procedure and Performance Qualification
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-276	Impregnation of Porous Nonferrous Metal Castings

	Criteria for
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-470	Maintainability Program for Systems and Equipment
MIL-STD-471	Maintainability Demonstration
MIL-STD-681	Identification Coding and Application of Hook-up and Lead Wire
MIL-STD-683	Crystal Units (Quartz); and Crystal Holders (Enclosures), Selection of
MIL-STD-701	Lists of Standard Semiconductor Devices
MIL-STD-710	Synchros, 60 and 400 Hertz
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-756	Reliability Modeling and Prediction
MIL-STD-781	Reliability Design Qualification and Production Acceptance Tests; Exponential Distribution
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-889	Dissimilar Metals
MIL-STD-965	Parts Control Program
MIL-STD-1130	Connections, Electrical, Solderless, Wrapped
MIL-STD-1132	Switches and Associated Hardware, Selection and Use of
MIL-STD-1261	Arc Welding Procedures for Constructional Steels
MIL-STD-1277	Splices, Terminals, Terminal Boards, Binding Posts, Terminal Junction Systems, Wire Caps; Electrical
MIL-STD-1279	Meters, Electrical Indicating, Selection and Use of
MIL-STD-1286	Transformers, Inductors, and Coils, Selection and Use of
MIL-STD-1334	Process for Barrier Coating of Anti-friction Bearings
MIL-STD-1346	Relays, Selection and Application

MIL-STD-1547	Parts, Materials, and Processes for Space and Launch Vehicles, Technical Requirements for
MIL-STD-1562	Lists of Standard Microcircuits
MIL-STD-1595	Qualification of Aircraft, Missile and Aerospace Fusion Welders
MIL-STD-1646	Servicing Tools for Electric Contacts and Connections, Selection and Use of
DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrical Initiated Explosive Devices)
MIL-STD-2175	Castings, Classification and Inspection of
MS33540	Safety Wiring and Cotter Pinning, General Practices for

DRAWINGS:

FAA

FAA Drawing C-21216	Standard Nameplate

OTHER PUBLICATIONS:

FAA Order

FAA Order 1320.33B	Equipment Modification and Facility Instruction Direction
FAA Order 3910.3A	Radiation Health Hazards and Protection

Regulations

FCC Rules and Regulations	
Volume II, Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
Volume X, Part 68	Connection of Terminal Equipment to the Telephone Network

NTIA Manual	National Telecommunications and Information Administration Manual of Regulations and Procedures for Radio Frequency Management

Handbooks

MIL-HDBK-5	Metallic Materials and Elements for Aerospace Vehicle Structures
MIL-HDBK-217	Reliability Prediction of Electronic Equipment
MIL-HDBK-251	Reliability/Design Thermal Applications
MIL-HDBK-472	Maintainability Predictions

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specified procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 Non-Government documents. The following documents of the issue in effect on the date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

STANDARDS:

AGMA

Various Standards
(American Gear Manufacturers Association
1330 Massachusetts Ave., N.W.
Washington, D.C. 20005)

ANSI

ANSI N2.1	Radiation Symbol
ANSI Z35.1	Accident Prevention Signs, Specification for
ANSI Z35.2	Accident Prevention Tags, Specification for
ANSI C39.1	Electrical Analog Indicating Instruments, Requirements for
ANSI Z53.1	Marking Physical Hazards, Safety Color Code for

(American National Standards Institute, Incorporated, 1430 Broadway, New York, NY 10018.)

ASTM

ASTM G21	Determining Resistance of Synthetic Polymeric Materials to Fungi, Practice for (American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103.)
ASTM D495	High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation, Test Method for
ASTM-B633	Electrodeposited Coatings of Zinc on Iron and Steel, Specification for
ASTM D568	Rate of Burning and/or Extent and Time of Burning of Flexible Plastics in a Vertical Position, Test Method for
ASTM D635	Rate of Burning and/or Extent and Time of Burning of Self-supporting Plastics in a Horizontal Position, Test Method for
ASTM D1000	Pressure-Sensitive Adhesive Coated Tapes Used for Electrical Insulation, Methods of Testing
ASTM D1868	Detection and Measurement of Partial Discharge (Corona) Pulses in Evaluation of Insulation Systems, Method for

AWS

AWS A2.4	Symbols for Welding and Nondestructive Testing
AWS A3.0	Welding Terms and Definitions (American Welding Society Inc., 550 N.W LeJeune Road, Miami, Florida 33126.)

IPC

IPC-CM-78	Guidelines for Surface Mounting and Interconnecting Chip Carriers
IPC-A-600	Acceptability of Printed Boards

Electronic Circuits, 3451 Church Street, Evanston, Il. 60203)

NFPA

NFPA 70	National Electrical Code (NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, Mass. 02269)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

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3.2 Definitions. The specifications referenced herein may provide a source for definitions. Such definitions are applicable to the extent of the reference.

3.3 Design and construction.

3.3.1 General. The equipment shall be designed to meet the requirements of the equipment specification and as specified herein. Approval shall be obtained from the Contracting Officer before committing any deviations from a specified design requirement.

3.3.1.1 Federal Communications Commission (FCC) registration. For equipment designed for interface and connection to either the public or private telephone networks, the contractor shall obtain FCC Registration in accordance with FCC Rules and Regulations, Part 68.

3.3.1.2 Continuous unattended duty. The equipment shall be designed for continuous unattended duty unless specifically stated otherwise.

3.3.1.3 Human engineering. Human engineering shall be in accordance with MIL-H-46855.

3.3.1.3.1 Noise criteria requirement. The noise criteria requirements shall apply to all equipment located in areas normally requiring verbal communication. As an example, this would include areas containing radar consoles but not areas involving power generators. If the equipment or system being provided by the contractor requires more than one rack of equipment in operation, the sound pressure level limit is applicable with all equipments operating simultaneously.

3.3.1.3.2 Sound pressure limits. Sound pressure levels generated by the equipment, with motors, blowers, and all other sources of acoustic noise in normal operation, shall not exceed the limits shown in Table I.

3.3.1.4 Commercial equipment. Refer to the equipment specification.

3.3.1.5 Design ranges. The design ranges are as follows:

3.3.1.5.1 Nominal Design and normal test values. The nominal design and normal test values are shown in Table II. Those values which are applicable will be specified in the equipment specification.

3.3.1.5.4 Non-operating conditions. For storage, shipping or transporting (non-operating), the following requirements apply:

(a)	Temperature	-50°C to +70°C
(b)	Relative humidity	Up to 100% including condensation due to temperature changes
(c)	Altitude	0 to 50,000 feet above sea level

3.3.1.5.5 Voltage range test conditions. The voltage range test conditions are as shown in Table IV.

3.3.2 Electrical. All wiring external to the equipment that interfaces with the power source shall be in accordance with FAA-STD-032, FAA-C-1217, and the National Electrical Code (NFPA 70) unless otherwise specified herein or in the equipment specification.

3.3.2.1 AC supply line: circuit and parts requirements.

3.3.2.1.1 AC line controls. Each control switch, relay, circuit breaker, fuse or other device, which acts to disconnect the AC supply line energizing the equipment, shall be in accordance with NFPA 70.

3.3.2.1.2 "Main power" switches. Switches or circuit breakers which function as "main power" switches, operating either directly or through a contactor to disconnect the AC line from the equipment shall break the AC line immediately after it enters the equipment via terminal block or connector, and before it reaches fuses or other parts.

3.3.2.1.3 AC line, input resistance to ground. For each individual chassis unit which is to be connected to the AC supply line, the DC resistance to ground from each input line terminal shall be not less than 1 megohm (AC supply line disconnected; fuses in place; AC line control contacts closed).

3.3.2.1.4 AC line connectors and power cord. The plugs and receptacles shall conform to W-C-596 and the power cord shall be a minimum 3 wire cord conforming to J-C-580. The voltage, current, wiring, and polarity shall be in accordance with the NFPA 70. Where a detachable power cord is provided on the

on the equipment. When practicable, this connector shall be on the lower right side of the rear of the equipment (when viewing the equipment from the rear).

b. The power cord shall be type SJ, 3 conductor, in accordance with Federal Specification J-C-580. One end shall have a female connector in accordance with W-C-596/76-1; the other end shall have a male plug in accordance with W-C-596/13-3.

3.3.2.1.5 AC line controls to be provided. Each equipment unit energized by direct connection to the AC line shall have, as a minimum, the following AC line controls:

a. Front-panel mounted "main power" switch or circuit breaker, permitting manual control of the application and removal of AC line voltage to the equipment.

b. Front-panel mounted AC line indicator light.

c. Front-panel mounted AC line indicating type fuse-holders, if circuit breakers are not provided.

3.3.2.1.6 Transformer isolation, DC power supplies. All DC power supplies energized from the AC line power source shall be isolated from the AC line through a power transformer with separate primary and secondary windings. The DC resistance from each input line terminal (with fuses in place and AC line control contacts closed to the signal or chassis ground) shall not be less than 1 megohm.

3.3.2.1.7 Convenience outlets. Convenience outlets provided on the equipment shall be a duplex isolated ground receptacle in accordance with W-C-596/12 or equivalent styles such as Hubbell #IG-5262, Bryant #5262-IG, Slater #IG-5262, or approved equivalent. Equipment wiring design shall provide for power to these convenience outlets from an AC line power source independent of the equipment primary power source. The convenience outlets and wiring shall be installed in accordance with the NFPA 70.

3.3.2.2 Circuit protection. All equipment output circuits shall be designed to include circuit protection and prevent opens or shorts at the output terminals from damaging the equipment. When the short or open is removed, circuit performance shall show no sign of performance degradation. In addition, transmitter output circuitry shall be so designed that, when operated at any voltage standing wave ratio (VSWR), the unit shall not be damaged nor any part exceed dissipation limits.

loads shall be balanced among the three phases so the total load on any one phase does not deviate from the average of the three phases by more than ten percent under normal operating conditions.

3.3.2.3.2 Power factor. The equipment shall be designed so that it presents a power factor not less than 85 percent lagging when operating under steady state conditions.

3.3.2.3.3 Effect of equipment on power source. The total root mean square (RMS) current generated at service conditions by the equipment and fed back into an AC supply system with linear impedance characteristics shall not exceed 5 percent of RMS full load current.

3.3.2.3.3.1 Inrush current. The peak total inrush current during start-up shall not exceed five (5) times the normal peak operating current. The duration of the inrush current shall not exceed eight (8) milliseconds (return to 110 % of normal).

3.3.2.3.4 Electrical overload protection. Electrical overload protection shall be as follows:

3.3.2.3.4.1 Current overload protection. Current overload protection for the equipment shall be provided by fuses, circuit breakers, or other protective devices for primary circuits.

3.3.2.3.4.2 Protective devices. Devices such as fuses, circuit breakers, time-delays, cutouts, or solid state current-interruption devices shall be used to open individual leads of a circuit whenever a fault occurs. Protective devices for wired-in equipment shall be connected to the load side of the equipment power switch (main circuit power disconnect). For portable equipment, a separating connector or the attachment plug and receptacle shall serve as the main circuit power disconnect (the protective device may be on either the line side or the load side of the equipment on-off switch).

3.3.2.3.4.3 Circuit breakers. When circuit breakers are used, the restoring or switching device shall be readily accessible to the operator. The circuit breaker shall give a visual indication when the breaker is tripped. Holding the switching device closed on an overload shall not prevent tripping of the breaker. Three phase circuit breakers shall be used for three-phase equipment and shall disconnect all phases if an overload occurs in any one phase. Circuit breakers shall not be used as switches unless such breakers have been specifically designed and tested for that type service.

need for such protective devices.

3.3.2.4 Test points, test facilities, and test equipment. Test points, test facilities, and test equipment (internal and external) shall be in accordance with MIL-STD-415.

3.3.2.4.1 Requirements. Built-in test devices shall maintain their accuracy under all operating conditions required by the equipment. These devices shall be provided with connections or access for their operational checkout or calibration.

3.3.2.4.2 Exceptions. The requirements for automatic checkout/automatic monitoring and built-in-test (BIT) capability of MIL-STD-415 shall not apply, unless specifically required in the equipment specification.

3.3.2.4.3 Locations. Test points and controls for adjustment shall not be located in compartments with voltage points of 300 volts or more. All test points and controls for adjustments shall be located to provide rapid access consistent with good human engineering and safety and to preclude accidental shock to personnel engaged in normal operating or maintenance activities.

3.3.2.4.4 Protection. Protection shall be provided in the test point circuitry to prevent equipment damage caused by the external grounding of test points or incorrect voltage applications.

3.3.2.4.5 Failures. Provisions for testing shall be so designed that any failure of built-in-test devices will not degrade equipment operation or cause equipment shutdown unless equipment is specifically designed to shut down in case of built-in-test device failure.

3.3.2.4.6 Data submittal. Test point data shall be submitted in accordance with MIL-STD-415.

3.3.2.5 Corona prevention. Corona and electrical breakdown prevention shall be as follows:

3.3.2.5.1 Corona prevention. When equipment is terminated with the cabling or other accessory equipment of which it is intended to be used, and when operated under the specified service conditions of humidity, temperature, condensation and barometric pressure with the specified power source frequencies and voltages (including commonly recurring transients), the corona level shall be compatible with the specified electromagnetic interference requirements. The corona level shall not degrade the equipment performance beyond the specified limits and shall not produce long-term degradation of the properties of materials or parts which may cause premature equipment failure.

are elements which contribute to formation of corona discharge.

3.3.2.5.2 Electrical breakdown prevention. The equipment shall be designed and manufactured with electrical clearance spacing, leakage (creepage) distances, and insulation levels adequate to prevent electrical breakdown under the specified service conditions of humidity, condensation, barometric pressure, temperature, service life, contamination, and operating voltage (including transients). Liquid dielectrics, gases other than ambient air, or pressurization to prevent electrical breakdown shall not be used unless specified by the detail equipment specification or approved by the procuring activity.

3.3.2.6 Grounding, bonding, shielding and transient protection. Requirements for grounding, bonding, shielding and transient protection shall be as specified in FAA-STD-020.

3.3.2.7 Electron (vacuum) tubes. The electronic design shall make maximum uses of solid state technology. Electron (vacuum) tubes shall not be used with the exception of cathode ray tubes (CRT).

3.3.3 Mechanical.

3.3.3.1 Furnishing of removable parts and mating connectors. Each equipment furnished by the contractor shall be complete with an installed set of fuses, lamps, plug-in relays, plug-in crystals, ferrule-type resistors, and other parts which are used in the equipment and which are similarly designed for quick removal and replacement. Parts which may be damaged by shipment in the operating sockets shall be packed in the normal part shipping container along with information to identify the operating socket. Where a coaxial or cable connector is provided on a piece of equipment furnished under the contract which will be connected to another piece of equipment not being furnished under the contract, the contractor shall supply the mating connector for the equipment under contract. Also, when two or more pieces of equipment furnished under the contract require interconnection, the contractor shall supply the necessary mating connectors. Telephone-type plugs and jacks are excluded from this requirement.

3.3.3.2 Installation. The equipment shall be so designed that it can be easily installed, removed, and reinstalled with a minimum of special tools and without extensive disassembly. In addition, the following also apply:

3.3.3.2.1 Pull-out drawers. All equipment pull-out drawers shall be of a full-suspension roller type with latching stops. Friction-slide construction is prohibited. Slides shall be of sufficient rigidity to prevent bowing and/or having rollers jump their track.

3.3.3.3 Construction. The equipment shall be constructed so that: a) no fixed part shall become loose, b) no movable part or permanently set adjustment shall shift its setting or position, and c) no degradation shall be caused in the performance specified in the equipment specification under the following mechanical service conditions:

3.3.3.3.1 Operating. Inclination at any angle up to ten degrees (10°) from the normal position.

3.3.3.3.2 Non-operating. Storage in the recommended position for a period of two years.

3.3.3.3.3 Moisture pockets. Pockets, wells, traps, and the like in which water or condensation could collect when the equipment is in normal position shall be avoided. Where moisture pockets are unavoidable and the equipment is not sealed, a provision shall be made for drainage of such pockets. Desiccants or moisture-absorbent materials shall not be used within moisture pockets. Where moisture buildup cannot be tolerated in sealed equipment or assemblies such as waveguides, the use of desiccants or other methods, such as gas purging, shall be considered.

3.3.3.3.4 Windows. Equipment windows, including dial windows, shall be shatterproof clear glass, or heat resistant plastic secured to the panels in bezels by means of clips or other devices to prevent displacement of the glass. Adhesives shall not be used to secure the glass.

3.3.3.4 Accessibility. Equipment shall be designed for optimum accessibility, operating compatibility, maintenance, electromagnetic compatibility, and enclosure requirements. For nonstructural purposes, all non-hinged shields or plates which are normally opened or removed in servicing an equipment, shall be secured with quarter-turn fasteners, except where this type of fastener does not provide tight enough contact for RF shielding purposes. Such fasteners shall be spaced on centers not exceeding 10 inches and shall be located around the entire periphery of the shields or plates.

3.3.3.4.1 Access. Each article of equipment and each major subassembly forming a part thereof shall provide for the necessary access to its interior parts, terminals, and wiring for adjustments, required circuit checking, and the removal and replacement of maintenance parts. Accessibility for testing and replacement does not apply to parts located in nonrepairable subassemblies or assemblies. For routine servicing and maintenance, unsoldering of wires, wire harnesses, parts or assemblies shall not be required in order to gain access to terminals, soldered connections, mounting screws and the like.

connection leads through the container.

3.3.3.4.3 Parts. Parts which are identified as replaceable parts for the equipment shall be easily removable and replaceable. These parts shall not be mounted by means of rivets, spot welding, or hard curing compounds. If, in order to check or remove a part, it is necessary to displace some other part, the latter part shall, whenever practicable, be so wired and mounted that it can be moved without being disconnected and without causing circuit detuning or instability. No unsoldering or soldering of connections shall be necessary when the front panel or any subchassis is removed for maintenance purposes. Design shall be such that where plug-in modules or assemblies are used, they can be easily inserted in the proper location when correctly oriented without damage to equipment or parts being engaged. Plug-in modules and assemblies shall be designed to prevent insertion when incorrectly oriented.

3.3.3.4.4 Enclosures. Accessibility to chassis, assemblies, or parts contained within cabinets, consoles or other enclosures shall be provided from outside the basic equipment through the use of access doors. Mounting such items on withdrawal slides, swinging doors, through cable extenders and cable retractors, and provisions for circuit card extenders will allow part or module operation in the open position. Automatic or manually operated locks shall be provided to lock the chassis in the servicing position. When withdrawal slides are used they shall be of guided sectional construction with tracks and rollers. Complete removal and access for servicing of electronic equipment contained within cabinets, consoles or other enclosures shall be provided from either the front or rear of the equipment. Guide pins (or locating pins), or the equivalent, shall be provided for mechanical alignment during mounting.

3.3.3.5 Thermal design. Thermal design shall be in accordance with the following:

3.3.3.5.1 Air filters. For equipment design requiring an air flow velocity through the filter not exceeding 300 feet per minute (FPM), disposable one inch thick impregnated glass wool filters per Federal Specification F-F-310; for air flow velocities through the filter exceeding 300 FPM, metal washable type filters in accordance with MIL-F-16552 shall be used. Air flow velocity through the metal filter shall not exceed 400 FPM. Filters shall not project outside the equipment enclosure and shall be removable from the outside (exterior) of the equipment cabinets without the necessity of opening access doors or moving any other equipment cabinets. Personnel shall be protected from harm of moving parts when replacing filters. Shutdown of fans shall not be required for filter replacement.

3.3.3.5.3 Auxiliary heating or cooling. Auxiliary heating or cooling means or devices may be employed when the equipment is to be operated for prolonged periods for test and checkout purposes and when such periods are not consistent with normal service conditions.

3.3.3.5.4 Forced air cooling. Forced air cooling shall be used only when natural cooling cannot provide sufficient cooling or when a significant reduction in overall size and weight can be realized. The design factors to be considered in determining the required fan or blower characteristics include such factors as amount of heat to be dissipated, the quantity of air to be delivered at the pressure drop of the enclosed equipment, the allowable noise level, the permissible level of heat that may be exhausted into the surrounding environment, and other pertinent factors affecting the cooling requirement of the equipment. Miniature blowers shall conform to MIL-B-23071. Induced drafts and ventilation by means of baffles and internal vents shall be used to the greatest practicable extent. Air filters shall be provided for air intakes for fan and blower cooled units when required to protect internal parts and shall be readily removable for cleaning without disassembly of the equipment. All ventilation openings shall be designed and located to comply with electromagnetic interference, undesired radiation and enclosure requirements. Air exhaust shall be so directed that it will not inconvenience operating personnel.

a. Equipment thermally designed for use with external source supplied cooling air may contain water or other contaminants detrimental to the equipment. Precautionary measures shall be taken to avoid direct impingement on internal parts and circuitry by channeling, or use of heat exchangers. If this is impractical, the water and contaminants shall be removed from the cooling air by suitable water and contaminant removal devices. To maintain consistency with adequate cooling, the minimum differential pressure (pressure drop) of the cooling air through the equipment heat exchanger or cold plate shall be maintained. Each separate piece of equipment being cooled shall be marked with the high and low operating temperature to which it is designed, the quantity and characteristics of air required to adequately cool the unit, and the resistance to air flow with respect to the air flow rate.

b. In the event of failure of the cooling device, an air flow interlock shall be used to provide a visual or aural warning.

Note: MIL-HDBK-251 may be used as a guide for detail information on thermal design of electronic equipment.

3.3.4.1 Operation under varying conditions. All specification requirements for operation shall be met when the equipment is operated at the specified duty cycle, and under all fixed or slowly varying conditions of AC line voltage and frequency, and DC voltage, within the ranges specified in Table IV. Under these conditions, the specification requirement for voltages, currents, power dissipation and temperature, as applicable to specific parts and materials, shall not be exceeded in starting and operating the equipment.

3.3.4.2 Fixed adjustment provision. The equipment shall be initially set up and adjusted under the normal test conditions, following the procedures in the equipment instruction book. No further adjustments shall be performed during testing for the entire cycle of test.

3.3.4.3 Equipment response to input power conditions. The contractor shall identify the equipment response to each condition to be tested. Refer to Table V, and Figure 2, as a guide.

3.3.5 Reliability. The contractor shall provide and maintain a reliability program when specified in the contract in accordance with the following:

3.3.5.1 Requirements. A reliability analysis shall be performed according to the techniques and data of MIL-HDBK-217. The attendant mean time between failure calculations, failure rates, and availability shall be performed for each equipment or item specified. A parts application review report and an identification of critical items as defined by MIL-STD-785 shall also be included. This data shall be furnished to the Government no later than 30 days prior to any preproduction or prototype assembly or design approval, whichever is the earlier, for review and approval. Unless specifically exempted, all electrical, electronic, electromechanical and mechanical parts shall be included in the analysis. Specific exempt items are parts such as structural members, braces, frames, and chassis racks, but not printed circuit boards, sockets, and solder joints.

3.3.5.2 Tests. Reliability tests shall be aimed at preventing, detecting, and correcting reliability design deficiencies, weak parts, and workmanship defects and provide reliability related information essential to acquisition, operation, and support management in contract requirements with the objective of establishing and maintaining an efficient reliability program according to life cycle phase. The reliability demonstration shall conform to MIL-STD-781.

3.3.6 Maintainability. When specified in the contract, the contractor shall provide and maintain a maintainability program in accordance with MIL-STD-470 as follows:

3.3.6.1 Requirements. The maintainability analyses shall contain a maintainability prediction based upon maintainability parameter values generated in conformance with MIL-HDBK-472. The maintainability demonstration shall conform to MIL-STD-471 or can be verified by MIL-HDBK-472.

3.3.6.2 Quantitative requirements. Quantitative maintainability requirements and verification or demonstration requirements should be established as appropriate to program plan.

3.3.7 Personnel safety. The design and development of electronic equipment shall provide fail-safe features for safety of personnel during the installation, operation, maintenance, and repair or interchanging of a complete equipment assembly or component parts thereof. Equipment design for personnel safety shall be equal to or better than the appropriate requirements of the Occupational Safety and Health Act (OSHA) as identified in Title 29, Part 1910, of the Code of Federal Regulations. Human engineering factors affecting safety shall be considered when establishing general or detailed design criteria. Rigorous detailed operational or maintenance procedures are not acceptable substitutes for an inherently safe design.

3.3.7.1 Electrical. The design shall incorporate methods to protect personnel from accidental contact with voltages in excess of 30 volts rms or dc during normal operation of a complete equipment. Means shall be provided so that power may be cut off while installing, replacing, or interchanging a complete equipment,assembly, or part thereof. Personnel shall be protected from capacitor discharges and when changing fuses or other electronic components. The main power ON-OFF switch located on the equipment (clearly labeled as such) shall cut off all power to the equipment. The power input side of the switch and the incoming power line connections shall be given physical protection against accidental contact.

3.3.7.1.1 Ground potential. The design and construction of the equipment shall ensure that all external parts, surfaces, and shields, exclusive of antenna and transmission line terminals, are at ground potential at all times during normal operation. Any external or interconnecting cable, where a ground is part of the circuit, shall carry a ground wire in the cable terminated at both ends in the same manner as the other conductors. In no case, except with coaxial cables, shall the shield be depended upon for a

as capacitors, transformers, relays, etc., shall be at ground potential or covered by an external casing made of insulating material. The external casing shall enclose the original case on all sides except the terminal sides. A point on the electrically conductive chassis or equipment frame shall serve as the common tie point for the static or power ground.

3.3.7.1.2 Hinged or slide mounted panels and doors. Hinges or slides are not considered adequate grounding paths, therefore doors and panels with hinges or slides shall be grounded by use of a flexible ground strap. A ground shall be considered satisfactory if the electrical connection between the door or panel and the system tie point exhibits a resistance of 0.1 ohm or less and has sufficient capacity to ensure the reliable and immediate tripping of equipment over-current protection devices.

3.3.7.1.3 Shielding. Except where a conflict with grounding requirements would be created, shielding on wire or cable shall be grounded to the chassis or frame. The shielding shall be at a sufficient distance from exposed conductors to prevent shorting or arcing between the conductor and the shielding.

3.3.7.1.4 Bonding in hazardous areas. Electronic equipment that is to be installed in areas where explosive or fire hazards exist, shall be bonded in accordance with NFPA 70.

3.3.7.1.5 Guarding of rf voltages. Transmitter output terminals, antennas and other devices that carry sufficient rf voltage that may burn or injure personnel shall be protected from accidental contact.

3.3.7.1.6 Interlocks. Various equipment designs require different approaches to the use of interlocks. Interlock use does not modify any other requirements of this standard and shall be consistent with equipment or system specifications. Interlocks shall conform to the following:

a. No interlocks are required when all potentials in excess of 70 volts are completely protected with guards or barriers to prevent accidental contact under all conditions of operation or any level of maintenance.

c. Bypassable interlock switches shall be momentary action (spring-return) switches marked "INTERLOCK BYPASS" and are provided to allow interlocked access doors and covers to be opened with a manual latch for "on" position to be operated in the exposed interlock switch, without removing power from the equipment. The bypass switches shall be located so that one person can operate the switch, open the door or cover, and set the manual latch.

d. Non-bypassable interlocks are required for voltage in excess of 500 volts, when the access door, cover, or plate is opened.

3.3.7.1.7 Shorting rods. Shorting rods shall be provided with all transmitting equipment where voltages are in excess of 70 volts rms or DC. Wherever size permits, shorting rods shall be stored within the transmitting equipment and be permanently attached and readily accessible to maintenance personnel.

3.3.7.1.8 Meter safety. Meters shall have provisions for overload bypass, or alternate protection to eliminate high voltage potential or current at the terminals in the event of meter failure. In addition, meters shall be provided with protection so that not over 1500V, maximum peak value, shall exist between any terminal of each meter and the metal panel on which it is mounted in the equipment.

3.3.7.1.9 High voltage protection. Assemblies operating at potentials in excess of 500 volts shall be completely enclosed from the remainder of the assembly and interlocked in accordance with the requirements herein. Test probe holes may be provided in the barriers or guards where maintenance testing is required. When the operation or maintenance of equipment is employing potentials in the excess of 300 volts peak, the equipment shall be provided with test points so these voltages can be measured at a relatively low potential level, but in no case shall the potential exceed 300 volts peak relative to ground. Test points with voltages above 30 volts shall have the conducting material recessed at a distance no less than the diameter of the probe hole and a minimum of 0.06 inch. If a voltage divider is used, the voltage divider resistance between the test point and ground must consist of at least two equally valued resistors in parallel. Full details shall be given in the instruction book or maintenance manual as to the method used in the equipment to obtain the voltage at the test points.

volts within two seconds or less after power removal. These protective devices shall be positive acting, highly reliable, and shall actuate automatically when the case or rack is opened. Shorting bars shall be actuated either by mechanical release or by an electrical solenoid when the door or cover is open. When resistive bleeder networks are used to discharge capacitors, the bleeder network shall consist of at least two equal valued resistors in parallel. The particular discharging device that is chosen must ensure that the capacitor is discharged to 30 volts or less within two seconds.

3.3.7.1.12 Connectors, electrical. In multiple electrical circuits, plugs and receptacles shall not be of similar configuration if the major unit contains explosive items. The design of the connector shall be such that the operator is not exposed to electrical shock or burns when normal disconnection methods are used. Exposed pin contacts shall not be energized (hot) after being disconnected from the socket contacts.

3.3.7.2 Radiofrequency (rf)/microwave, X, and laser radiation limits.

3.3.7.2.1 Applicability of federal standards. The design of all equipment for which a federal standard exists under the Code of Federal Regulations (CFR), Title 21, Chapter I, Subchapter J shall conform to the appropriate federal standard.

3.3.7.2.2 Radiation hazards and protection. All electronic equipment or electrical devices capable of emitting x-radiation or RF/microwave radiation between 300 kHz and 100 GHz shall be designed, fabricated, shielded, and operated to the requirements of FAA Order 3910.3A.

3.3.7.2.3 Laser radiation. Laser equipment and system design, installation, and written operational and maintenance procedures shall conform to CFR, Title 21, Chapter I, Subchapter J, Part 1040. If Title 21 cannot be met because of operational requirements, an exemption shall be requested from FAA and applicable Government laser safety regulations shall be used as a design requirement.

3.3.7.3 Switches.

3.3.7.3.1 Safety switches. Safety switches which deactivate associated mechanical drive units shall be provided for the purpose of disconnecting these units without disconnecting other parts of the equipment. All remotely located units and assemblies shall have provisions to prevent overriding safety switches to allow independent disconnecting in the associated equipment.

to personnel while installing, operating, and maintaining the equipment. The design of rack mounted equipment shall locate the center of gravity as low as practical to minimize tipping over. Suitable protection shall be provided to prevent contact with moving mechanical parts such as gears, fans, and belts when the equipment is complete and operating. Sharp projections on cabinets, doors, and similar parts shall be avoided. Doors or hinged covers shall be rounded at the corners and provided with stops to hold them open. Provisions shall be enhanced to prevent accidental pulling out of drawers or rack mounted equipment components which could cause equipment damage and injury to personnel. Equipment power switches shall be so designed and located that accidental contact by personnel will not change the equipment state.

3.3.7.4.1 Mechanical interconnection. The design shall provide positive means to prevent the inadvertent reversing or mismating of fittings, couplings, fuel, oil, hydraulic, and pneumatic lines; mechanical linkage; and instrument leads and electrical connections. When prevention of mismating by design considerations is not feasible, coding or marking shall be employed when approved by FAA. Coding and marking will not be approved as a substitute for proper design of items involving explosives, emergency, or safety critical systems.

3.3.7.4.2 Cathode ray tubes. Provisions shall be incorporated to protect personnel from injury due to implosion of cathode ray tubes.

3.3.7.4.3 Glass fibers. Glass fiberous materials shall not be used as the outer covering on cables, wire or other items where they may cause skin irritation to operating or maintenance personnel unless specified in the equipment specification.

3.3.7.5 Markings, signs, tags, and symbols.

3.3.7.5.1 Markings.

a. Guards, barriers, and access doors, covers or plates shall be marked to indicate the hazard which may be reached upon removal of such devices. When possible, marking shall be located such that it is not removed when the barrier or access door is removed. Additionally, hazards internal to a unit shall be marked adjacent to hazards if they are significantly different from those of surrounding items. Such a case would be a high voltage terminal in a group of low voltage devices.

expectancy of the equipment on which they are affixed.

a. For potentials between 70 and 500 volts, warning signs or shield labels shall read, as a minimum, "CAUTION - (Insert maximum voltage applicable) VOLTS". The letters shall be yellow gothic capitals on a black background. The voltage shall be black on a yellow background.

b. For potentials in excess of 500 volts, warning signs or shield labels shall read, as a minimum, "DANGER - HIGH VOLTAGE - (Insert maximum voltage applicable) VOLTS". The letters shall be gothic capitals, color white or aluminum with a red background. The voltage shall be black on a white or aluminum background.

c. Microwave or radio frequency radiation signs shall be in accordance with FAA Order 3910.3A. Labels shall be provided on all radiation shields to warn personnel of the radiation hazards involved upon their removal. Any item which can emit radiation levels in excess of those specified herein shall be labeled. Warning signs shall be posted in all areas having electronic equipment designed to operate between 300 kHz and 100 GHz with intended electromagnetic radiation levels exceeding those specified herein.

d. Laser labels shall be in accordance with CFR, Title 21, Chapter I, Subchapter J, Part 1040.

e. Shields which protect personnel from X-radiation shall be labeled.

3.3.7.5.3 Tags. Coding for accident prevention tags shall be in accordance with ANSI Z35.2.

3.3.7.5.4 Marking of radioactive materials. The marking or labeling of commodities containing radioactive materials shall be in accordance with Nuclear Regulatory Commission Rules and Regulations CFR, Title 10, Chapter I, Part 20 and OSHA Regulation CFR, Title 29, Part 1910.96.

3.3.7.5.5 Symbols. The following symbols shall be used as applicable:

a. Ionizing radiation hazard - ANSI N2.1.

3.3.7.6.1 Carcinogens. Certain chemicals have been identified by the Occupational Safety and Health Administration (OSHA) as cancer-producing substances (carcinogens). Before using any materials which might contain these chemicals, they should be evaluated in accordance with the CFR, Title 29, Chapter XVII, Part 1910.

3.3.7.6.2 Gases or fumes. The materials installed in the equipment and under service conditions specified in the specific equipment specification, shall not liberate gases which when combined with the atmosphere form an acid or corrosive alkali, nor shall they liberate toxic or corrosive fumes which would be detrimental to the performance of the equipment or health of the equipment operators. The materials also shall not liberate gases which will produce an explosive atmosphere.

3.3.7.6.3 Restricted materials. Mercury and asbestos shall not be used.

3.3.7.6.4 Radioactive materials. Use of radioactive materials shall conform to Nuclear Regulatory Commission Regulations and shall require approval of FAA. Radium shall not be used to achieve self-luminosity.

3.3.8 Electromagnetic compatibility. Electromagnetic compatibility shall be as follows:

3.3.8.1 Requirements. All electronic equipment shall meet the technical standards as specified in the National Telecommunications and Information Administration Manual of Regulations and Procedures for Radio Frequency Management (NTIA Manual), FAA-STD-020, and MIL-STD-461. In the event of conflict, the following descending order of precedence shall prevail: NTIA Manual, FAA-STD-020, MIL-STD-461.

3.3.8.2 Tests. Tests and test methods shall be as specified in MIL-STD-462. For radar equipment and systems, the NTIA Manual shall also apply.

3.3.8.3 FCC Type Acceptance. The contractor shall obtain FCC Type Acceptance in accordance with FCC Rules and Regulations, Part 2.

3.4.1.1 Soldering. Soldering and assembly shall be in accordance with ANSI/IPC-S-815, and modified as follows:

3.4.1.1.1 Fluxes. Fluxes shall be type R or RMA per MIL-F-14256 (liquid) or QQ-S-571 (cored), as applicable.

3.4.1.1.2 Other Fluxes. Other fluxes (such as type RA or WS (water soluble)) require written approval from FAA, prior to use. Requests for such approval shall include:

a. Detailed cleaning procedure.

b. Insulation resistance test methods.

c. Minimum insulation test values (nominally 100 megohms).

3.4.1.2 Assembly. Assembly procedures and requirements shall be in accordance with IPC-CM-770 or IPC-CM-78, as applicable, except the term "not recommended" shall be interpreted as "reject".

3.4.1.3 Printed boards. After exposure to manufacturing/assembly process, the printed board acceptance requirements shall be in accordance with IPC-A-600.

3.4.1.4 Printed assemblies. Printed assembly requirements shall be in accordance with ANSI/IPC-A-610.

3.4.2 Classification. Unless otherwise specified, electronic assemblies shall be of high reliability, Class III as defined in ANSI/IPC-S-815.

3.4.3 Certification. Solder operators and inspectors shall have been trained and passed a proficiency test.

3.5 Parts.

3.5.1 Application, use and orientation of parts. Application and use of parts shall be in accordance with the respective applicable specifications and in accordance with requirements of this specification. However, if such specifications do not cover use and applications for a given part, the manufacturer's recommendations shall be followed. When the equipment is in its normal operating position, parts shall be oriented in accordance with the

specification, or in other specifications which are directly applicable to the equipment specification. Parts not conforming to these requirements are defined as nonstandard parts.

3.5.1.2 'Nonstandard' parts. Nonstandard parts require Government approval under procedures given in Appendix I, prior to adoption by the contractor for design and use in the equipment. The contractor shall not order or manufacture such parts until said contractor has complied with either the equipment specification or Appendix I requirements and received written approval from the Contracting Officer or designated Technical Officer for usage in the equipment. All requests for approval of nonstandard items shall be submitted by the contractor to the Contracting Officer in accordance with Appendix I.

3.5.1.3 Electrostatic discharge. Certain types of semiconductor devices are susceptible to electrostatic discharge damage. An Electrostatic Discharge Control Program shall be implemented and maintained in accordance with DOD-STD-1686.

3.5.1.4 Contractor's responsibility. Government approval of nonstandard parts shall not relieve the contractor of his responsibility for meeting all related specification requirements. Parts specified herein as required to meet requirements of military specifications shall be in accordance with 4.5.

3.5.2 Derating policy and design tolerance values.

3.5.2.1 Electronic part derating policy. In the application of electronic parts, the parts selected shall be used within their electrical ratings and environmental capabilities (e.g., any ambient or hot spot temperatures, voltage, current, or power dissipation). Derating shall be accomplished as necessary to assure the required equipment reliability within the specified operating conditions.

3.5.2.2 Design tolerance (end-of-life) values. In designing circuitry for long term performance, consideration shall be given to part parameter drift. The circuits should be designed to perform their intended function accommodating this long term parameter drift.

fasteners, and other devices, that are specifically called out in this specification. Other types of bonding, securing, and fastening shall not be used.

3.5.4 Interchangeability. Interchangeability shall be as defined in MIL-STD-280 and in accordance with the following:

3.5.4.1 Design tolerances. Provisions shall be made for design tolerances. Items having the dimensions and characteristics permitted by the item specification may be used as replacements without selection or departure from the specified equipment performance.

3.5.4.2 Use of standard items. Standard items shall be used when available. When existing standard items are not available and permission is granted by FAA for use of a nonstandard item, the equipment shall be designed so the nonstandard item can be replaced by the standard item. Appropriate space, mounting holes, and other necessary provisions shall be provided for this purpose unless they conflict with the specified equipment size requirement. When a provision is made for substituting or replacing items, the standard item being used for replacement shall be identified in the applicable documentation.

3.5.4.3 Choice of parts. The item having the broadest characteristics and tolerances that will fulfill the equipment performance requirements shall be used. FAA approval is required to substitute lower quality/performance items where procurement lead time causes development or production delays.

3.5.5 Electrical parts.

3.5.5.1 Batteries. Batteries shall not be used unless specifically required by the equipment specification, and shall be in accordance with the following:

3.5.5.1.1 Battery compartment. The battery compartment shall be provided with devices to firmly secure the batteries. Adequate room shall be provided for battery installation, maintenance, testing, and removal without disassembly of the equipment. The battery compartment shall prevent pressure buildup from heat, gasses, liquids, or chemicals released during battery operation, charging, deterioration, or rupture, and shall also prevent such materials from entering the electronic compartment.

be requested through PAA from the following sources:

US Army Electronics Technology and Devices Laboratory
ATTN: DELET-P
Ft Monmouth, NJ 07703

Naval Surface Weapons Center
ATTN: R33
Silver Spring, MD 20910

Air Force Wright Aeronautical Laboratories
ATTN: POOC
Wright Patterson AFB, OH 45433

3.5.5.1.3 Installation marking. Connections, polarity, minimum acceptable voltage for equipment operation, nominal voltage, and type(s) of batteries required shall be marked as applicable in a prominent place on or adjacent to the battery compartment.

3.5.5.1.4 Warning label. Except for equipment requiring permanent battery installation, battery-powered equipment shall be labeled externally as follows:

WARNING
REMOVE BATTERIES BEFORE
SHIPMENT OR INACTIVE STORAGE
OF 30 DAYS OR MORE

3.5.5.2 Capacitors. Capacitors shall be in accordance with the following:

3.5.5.2.1 Selection. Capacitors shall be selected and applied in accordance with MIL-STD-198. Established reliability (ER) parts shall be used wherever possible. For critical applications, minimum level shall be failure rate "R."

3.5.5.2.2 Variable, compression type. Compression (spring plate) type variable capacitors shall not be used.

3.5.5.2.3 Fixed, paper dielectric. Paper, paper-plastic, and metallized paper capacitors in molded cases shall not be used.

3.5.5.2.4 Fixed, tantalum electrolytic. Tantalum capacitors shall be tantalum cased units in accordance with MIL-C-39006/22.

following:

3.5.5.3.1 Selection and application. Circuit breakers shall be selected from MIL-STD-1498. Circuit breakers conforming to W-C-375 may be used where commercial power sources are utilized. Trip-free circuit breakers shall be used unless otherwise specified or approved by the procuring activity. Non-trip-free circuit breakers shall be used only when the application requires overriding of the tripping mechanism for emergency use. Circuit breakers shall be compatible with the currents encountered.

3.5.5.3.2 Manual operation. Circuit breakers shall be capable of being manually operated to the ON and OFF positions.

3.5.5.3.3 Internal access. Access to the internal mechanism of a circuit breaker shall require the breaking of a seal or other acceptable restriction.

3.5.5.3.4 Position identification. Circuit breakers shall have easily identified ON, OFF and TRIPPED positions except that the TRIPPED position may be the same as the OFF position with no differentiation between OFF and TRIPPED being required.

3.5.5.3.5 Orientation. Circuit breakers shall operate when permanently inclined in any direction up to 30 degrees from the normal vertical or normal horizontal position. The rated point of an inclined unit shall not vary more than ± 5 percent of the current specified for normal position mounting. Circuit breakers used on portable test equipment shall operate within the limits of the detail specification when the equipment is in any position or rotation about its three principal axes.

3.5.5.3.6 Vertical mounting. Vertically mounted circuit breakers with toggle handle actuators shall have the ON position upward.

3.5.5.3.7 Insulating materials. Insulating materials used in the construction of circuit breakers shall neither support combustion nor give off noxious gases when subjected to the electrical arcing found in circuit breakers. Insulating materials subjected to arcing on instantaneous high current tripping shall be nontracking when subjected to the specified current limit.

3.5.5.3.8 Location. The circuit breakers shall be located on the front panel when practical.

3.5.5.4 Crystal units, quartz. Quartz crystal units shall be selected in accordance with MIL-STD-683. Crystal oscillator units shall conform to MIL-O-55310.

3.5.5.5 Delay lines. Fixed electromagnetic pulse delay lines shall be in accordance with MIL-D-23859.

3.5.5.6 Electrical connectors. Electrical connectors shall be in accordance with the following:

3.5.5.6.1 Selection. Selection and use of electrical connectors shall be in accordance with MIL-STD-1353 and as specified herein. Intended use information contained in the individual connector specifications shall be considered prior to making connector selections. Contact crimp, installing, and removal tools shall be in accordance with MIL-STD-1646 or as specified in the individual connector specifications. However, contractors may use tooling as recommended by the contact or tooling manufacturer provided that the finished crimp meets all of the performance requirements of the contact and connector specification. The variety of these tools required within a system shall be kept to a minimum. Maintenance instructions and other data supplied by the contractor shall list the military standard tools and contacts.

3.5.5.6.2 Audio-frequency and communication connectors. Special purpose connectors conforming to MIL-C-10544 or MIL-C-55116 shall be used in audio frequency applications, such as head sets and chest sets excluding pilots' helmets. Connectors conforming to appropriate ANSI standards may be used for low level, three wire and audio input circuits in fixed plant noncritical sound equipment.

3.5.5.6.3 Connectors with thermocouple contacts. All connectors used in conjunction with thermocouples shall have their contact materials identified by one of the following methods:

a. Nameplate securely attached to each connector half or mounted on the panel-mounted receptacles.

b. By means of insulation sleeving or other markers designed for attachment around wire bundles. Markers shall be attached adjacent to the plug. Contact materials shall be identified with abbreviations in accordance with Table VI.

MIL-STD-1353. Connectors used for external applications shall be pressurized and waterproof in the mated and unmated condition in accordance with the requirements of Classes C or L. Connectors used internally (within a protective enclosure such as a shelter) may be in accordance with Class R provided waterproofing or pressurization is not a requirement for the application. In applications where right angle bend is required, center lock screw multicontact connectors shall conform to MIL-C-12520 and MIL-C-55181, where practical.

3.5.5.6.6 Connectors, general utility. Polarized connectors are the preferred styles. They shall be used where automatic grounding must be provided to ensure safety to equipment and personnel. Connectors for general utility power applications shall conform to Section 106 of MIL-STD-1353.

3.5.5.6.7 Plugs and jacks (telephone type). Telephone type jacks and plugs shall conform to MIL-J-641 and MIL-P-642.

3.5.5.6.8 Test jacks. Test jacks shall conform to Section 105 of MIL-STD-1353.

3.5.5.6.9 Rf connectors. Rf connectors as well as rf test points shall conform to Section 200 of MIL-STD-1353. Adapters used with rf connectors shall conform to MIL-A-55339.

3.5.5.6.10 Printed assemblies. Printed assembly connectors shall conform to Section 104 of MIL-STD-1353.

3.5.5.6.11 Connector wiring. Not more than one wire shall be routed through any hole in the grommet of an environmentally sealed connector. Multiple conductors may terminate in a contact provided the sum of the circular mil areas of the conductors do not exceed the maximum circular mil area of which the contact is rated.

a. Quantity and location. Unused connector contacts or contact positions for external circuits shall be available for future use, and shall be located on the periphery (outer contacts) of the connector. The minimum quantity shall be as specified below:

Total number of used contacts in connector	Unused contacts or contact positions required (min)
1 thru 25	2
26 thru 100	4
101 or over	6

b. An extra connector shall not be used to meet this requirement without the approval of the procuring activity.

c. Size and rating of extra contacts. The size and rating of extra contacts shall be compatible with other contacts within the connector.

d. Crimp contact connectors. All contact positions shall be filled when environmentally sealed connectors are used.

e. Sealing plugs. Sealing plugs shall be inserted in the grommet holes of unused contacts in environmentally sealed connectors.

f. Potted connectors. For potted connectors, each unused contact shall have a maximum gauge wire of 6 inches minimum length attached and identified with the contact designation for future use. For connectors external to the unit, the wire end shall be suitably capped to prevent moisture from entering the connector.

3.5.5.6.13 Protective measures. All unmated connectors shall be protected with metal or plastic caps or otherwise suitably protected during maintenance, storage and shipment. Protective caps specified by military specifications or military standards and designed for mating with specific connectors shall be used. Unmated connectors which may contain electrically "hot" circuits while in environmentally hazardous areas shall be covered with moistureproof and vaporproof caps. Connectors on enclosed cabinet mounted equipment need not be provided with protective caps unless an environmental hazard exists.

3.5.5.6.14 Potting. Potting materials shall conform to appropriate military specifications and shall not deteriorate in chemical, physical or electrical properties, under specified system/equipment environment.

continuous flame, both the receptacle and mating plug shall be class K. If flame integrity only is necessary without the need for electrical continuity, a class K receptacle must be used, but the mating plug may be of any type and class. In all cases, the plug and receptacle shall be environment resisting.

3.5.5.6.17 Nonmating. Where two or more connectors (other than coaxial types) are used on a given equipment unit, interchanging of the mating connectors shall be rendered impossible by differing contact arrangements, keying, or other positive means.

3.5.5.6.18 Receptacles and cords. The AC line receptacles and power cords shall be in accordance with paragraph 3.3.2.1.4.

3.5.5.6.19 Electrostatic discharge. Control provisions shall be implemented in accordance with good engineering practice to prevent ESD damage.

3.5.5.6.20 Accessories. Connector accessories shall be compatible with the connector and cabling used.

3.5.5.7 Filters, electrical. Electrical filters shall be selected and used in accordance with MIL-STD-1395, with the following additional requirements:

3.5.5.7.1 Nonstandard. MIL-F-18327 nonstandard cases and mountings, designated "YY and "ZZ" shall not be used. The temperature class shall be limited to R, S, and V. The life expectancy shall be limited to X.

3.5.5.7.2 Temperature. The operating temperature range shall be limited to B and C of MIL-F-15733.

3.5.5.8 Fuses, fuseholders, and associated hardware.

3.5.5.8.1 Selection. Fuses, fuseholders, and associated hardware shall be selected from MIL-STD-1360. Fusing shall be arranged so that fuses in branch circuits will open before the fuses in the main circuit. Fuses are not intended to perform the function of thermal overload relays or circuit breaker devices. Fuses shall have ratings which correspond to those of the parts and wiring they protect. Fuse ratings shall be compatible with both starting and operating currents. All fuses shall be easily replaceable. Connections to extractor post type fuse holders shall be such that the load is connected to the fuse terminal which terminates in the removable cap assembly.

3.5.5.8.3 Ratings. The ampere rating of all fuses used in the equipment shall be indicated adjacent to the fuse holder in letters at least 3/64 inch high. When spare fuses are included, "SPARE" shall be marked adjacent to each spare fuse holder.

3.5.5.9 Indicator lights. The indicator lights shall be flange or bayonet types conforming to MIL-L-3661. Selection of colors for indicator light lens shall be in accordance with 3.3.1.3. Indicator lights shall not be connected in series. LED's, when used as indicator lights, shall conform to MIL-S-19500.

3.5.5.10 Meters, electrical indicating. Meters shall be rectangular panel type electrical indicating instruments in accordance with ANSI Standard C39.1, or other styles in accordance with MIL-STD-1279, and as follows:

3.5.5.10.1 Size. The size for meters shall be 2 1/2 or 3 1/2 inches nominal. For time measurement, 1 inch meters are allowed.

3.5.5.10.2 Restriction. Rectifier meters shall not be used to indicate powerline voltage or current, filament/heater voltage or current.

3.5.5.10.3 RF fields. Meters shall be suitably protected where they are physically located or electrically connected, because stray RF fields or currents developed within the equipment could cause damage to the meters or cause false indications.

3.5.5.10.4 Clearance. Clearance behind the panel shall be sufficient to accommodate replacement meters having the maximum depth behind panel allowed by ANSI C39.1 for the same basic size and type of meter.

3.5.5.10.5 Indicating range. For analog meters, the normal operating value of the quantity to be indicated shall be between 1/3 and 3/4 of full scale deflection.

3.5.5.11 Meter switching. Where meter switching is employed, the requirements in the following subparagraphs shall apply:

3.5.5.11.1 Power Supply. The power supply or other basic source of the electrical quantity being metered shall have an output voltage, at its highest potential point, which shall not exceed 500 volts peak relative to ground, under all circumstances of parts failure and load removal.

actual voltage or current, where M is the percent-of-full-scale accuracy (rated, not actual) of the meter movement on its basic range (multipliers and shunts of meter switching circuit not connected to the meter terminals).

3.5.5.11.4 Limitation. Meter switching shall be limited, in the case of current-indicating meters, to meter movements requiring 1 milliampere or less for full-scale deflection.

3.5.5.12 Meter shunts and transformers. Meter shunts and transformers shall be in accordance with MIL-S-61 or MIL-I-1361.

3.5.5.13 Microelectronic devices. Microelectronic devices, shall be in accordance with the following:

3.5.5.13.1 Requirements. Microelectronic devices shall conform to MIL-M-38510, product assurance level class B, as a minimum. Class S is the highest product assurance level of MIL-M-38510 and is intended for space applications or other applications requiring the product assurance provisions of class S. Unless otherwise specified, the order or preference shall be as follows:

a. MIL-M-38510 JAN microcircuits listed in MIL-STD-1562, Section I.

b. Other MIL-M-38510 JAN microcircuits, subject to FAA approval.

c. DESC Selected Item Drawing microcircuits, subject to FAA approval.

d. Other microcircuits (see 4.5), subject to FAA approval.

b. Required environmental, endurance (life) and other design capability tests.

c. Quality assurance requirements, including screening and lot quality conformance (acceptance) tests. All devices shall be required to pass the MIL-STD-883 class B requirements of screening in accordance with method 5004.1 and group A and B lot quality conformance in accordance with method 5005.1. Group C and D lot qualification tests shall have been performed to method 5005.1 or within 2 years of the lot date code.

3.5.5.13.3 Hermetic seal. Microcircuit devices shall be hermetically sealed in glass, metal or ceramic (or combinations of these) packages. No organic or polymeric materials shall be used inside the microcircuit package.

3.5.5.13.4 Reliability. When required by the contract, reliability predictions for system/equipment design using microcircuit devices shall be prepared in accordance with MIL-HDBK-217.

3.5.5.14 Motors, dynamotors, rotary power converters and motor-generators. Motors not capable of carrying locked-rotor current continuously when stalled, without permanent damage, shall be protected by use of fuses, circuit breakers, or manual reset thermal cutouts. Manual reset thermal cutouts shall be readily accessible for resetting. Multiphase motors shall be protected from damage which could occur as a result of loss of one phase of the power source.

3.5.5.15 Printed wiring and printed wiring boards. Printed wiring shall be obtained from certified suppliers in accordance with the following:

3.5.5.15.1 Rigid printed wiring boards. Rigid printed wiring boards for single-sided, double-sided, and multilayer construction shall conform to MIL-STD-275 and MIL-P-55110. The materials used for single-sided and double-sided printed wiring boards shall conform to MIL-P-13949. The materials used for multilayer printed wiring boards shall conform to MIL-P-13949 and MIL-F-55561.

3.5.5.15.2 Flexible printed wiring boards. Flexible printed wiring boards shall conform to MIL-P-50884.

selected from MIL-STD-1277. Stud terminals, feed-through terminals and binding posts shall be selected from MIL-STD-1277.

a. Terminal boards shall be secured only by bolts (machine screws) and shall be capable of ready removal and replacement. They shall be mounted in the position that will best facilitate the testing of the equipment.

b. The maximum number of lugs to be connected to any one terminal on a terminal board shall be as specified in the detail specification sheets for stud-type terminal boards. When not specified, the maximum shall be not more than four lugs to any one terminal of a board except that no more than two lugs are allowed for screw-type terminal boards conforming to MIL-T-55164. Accessories such as stud connectors, straddle plates, jumpers and terminal board lugs shall be counted as lugs for this purpose.

c. Adequate spacing or barriers shall be employed between adjacent stud or feed-through terminals or binding posts to prevent corona discharge, breakdown, and low-leakage resistance under specified environmental conditions such as high humidity (including condensation) and high altitude for the particular application. Terminals shall not turn, loosen or deteriorate when the equipment is subjected to specified service conditions, such as shock and vibration. Terminals mounted on boards shall not cause cracking or delamination of the board.

d. Installation of terminals shall be in accordance with paragraph 3.4.

e. Terminal boards used in interconnecting units shall have 10 percent extra spare unused terminals, but in no case less than two.

3.5.5.16 Readout devices. Incandescent type Readout devices shall be in accordance with MIL-R-28803. Visible light emitting diode displays shall conform to MIL-D-87157, quality level B.

3.5.5.17.2 Solid state relays. Solid state relays shall be selected from MIL-STD-1346 or shall conform to MIL-R-28750.

3.5.5.17.3 Load transfer relays. Relays which are not specifically designed for load transfer applications shall not be used for this purpose.

3.5.5.18 Resistors and thermistors. Resistors and thermistors shall be in accordance with MIL-STD-199, MIL-T-23648, or MIL-R-55342. Established reliability (ER) parts shall be used wherever possible. Minimum failure level shall be "R."

3.5.5.19 Servo devices. Servomotors, synchros, resolvers, tachometer generators, encoders, and transolvers shall be in accordance with the following:

3.5.5.19.1 Rotary servo devices. Rotary servo devices shall conform to MIL-S-81963.

3.5.5.19.2 Servomotors. Servomotors shall conform to MIL-S-22432 or MIL-S-22820 when the motor is coupled to a tachometer generator.

3.5.5.19.3 Synchros. Synchros shall be selected and applied in accordance with MIL-STD-710.

3.5.5.19.4 Resolvers. Resolvers shall be selected and applied in accordance with MIL-STD-1451.

3.5.5.19.5 Linear resolvers. Linear resolvers shall conform to MIL-R-50781.

3.5.5.19.6 Tachometer generators. Tachometer generators shall conform to MIL-T-22821 or to MIL-S-22820 when the tachometer generator is coupled to a servomotor.

3.5.5.19.7 Transolvers. Transolvers shall conform to MIL-T-83727.

3.5.5.19.8 Encoders. Encoders shall conform to MIL-E-85082 for general application. For altitude reporting applications, encoders shall conform to MIL-E-81512.

3.5.5.20.2 Nonavailability. When these parts are not available, parts shall be specified/procurred in accordance with the requirements of MIL-STD-750 or MIL-STD-1547.

3.5.5.20.3 Tests/screening. The devices selected, shall be process conditioned, tested, and screened equivalent to the TX requirements for similar types. Critical usage applications specified by the equipment specification, shall be tested and screened to MIL-S-19500.

3.5.5.20.4 Hermetic sealing. All semiconductor devices shall be hermetically sealed in glass, metal, metal oxide, ceramic, or combinations of these. No plastic (organic or polymeric) encapsulated or sealed devices shall be used.

3.5.5.21 Sockets and accessories. Sockets and accessories for plug-in parts shall be in accordance with the following:

3.5.5.21.1 Sockets. Sockets for plug-in electronic parts shall be of the single unit type. They shall conform to MIL-S-12883 or MIL-S-83734. The use of sockets to mount integrated circuits shall not be used.

3.5.5.21.2 Magnetic shielding. Magnetically sensitive devices shall be shielded to minimize the effects of strong magnetic fields. Such devices shall be shielded to assure that their performance will not be degraded beyond equipment specification limits by a magnetic field external to the equipment, representative of the specified operating environmental conditions.

3.5.5.21.3 Clamps. Plug-in parts shall be securely retained in their sockets in their proper position under specified service conditions of shock and vibration. When a positive holding device is used, it shall be of the release type to allow replacement of the plug-in part.

3.5.5.21.4 Mounting pads and insulator disks. Mounting pads and insulator disks required for use with small electrical or electronic devices shall conform to MIL-M-38527.

3.5.5.21.5 Dissimilar Metals. The requirements of paragraph 3.6.3 apply to part/socket interfaces.

MIL-S-83731.

3.5.5.22.2 Interlock switches. When interlock switches, are used, they shall be in accordance with MIL-S-8805/56.

3.5.5.22.3 Detent action. Switches shall have a detent action to indicate activation. Exceptions are switches with momentary positions, an increase-decrease functions, or those which are not manually operated.

3.5.5.22.4 Slide switches. Slide switches shall not be used.

3.5.5.23 Crimp terminals. Crimp terminals shall be in accordance with the following:

3.5.5.23.1 Crimp terminations. The applicable part specifications shall control the crimp termination.

3.5.5.23.2 Number of wires per terminal crimp. In no case shall the total circular mil area of the terminated wires exceed the circular mil area capacity of the crimp terminal.

3.5.5.23.3 Lug terminals. Lug terminals shall be selected from MIL-STD-1277.

3.5.5.23.4 Crimping of terminals. Crimping of terminals shall be accomplished so the connections will meet the resistance (voltage drop) and tensile strength requirements and tests of MIL-T-7928.

3.5.5.23.5 Crimping tools. Crimping tools shall be as specified in the individual terminal specifications. However, contractors may use tooling recommended by the terminal or tooling manufacturer provided the finished crimp meets all of the performance requirements of the terminal specification. Maintenance instructions and other data supplied by the contractor shall list the military standard tools, terminals and splices.

3.5.5.24 Transformers, inductors, and coils. Transformers, inductors, and coils shall be in accordance with the following:

3.5.5.24.1 Selection. Selection of transformers, inductors, and coils shall be in accordance with MIL-STD-1286 and the following subparagraphs:

3.5.5.24.2 Audio, power, and high-power pulse transformers and inductors. Audio, power, and high-power pulse transformers and inductors shall conform to MIL-T-27, grade 4, 5, or 6, and class Q, R, S, V, or T.

3.5.5.24.4 Radio frequency coils. Radio frequency coils shall conform to grade 1, class 0, A, B, or C of MIL-C-15305 except that radio frequency coils, fixed, molded, with established failure rate levels shall conform to MIL-C-39010, Class A, tolerance K, failure rate P, as a minimum.

3.5.5.24.5 Low-power pulse transformers. Low-power pulse transformers shall conform to MIL-T-21038, grade 4 or 5 and class Q, R, S, T or U.

3.5.5.24.6 Chip inductors. Chip inductors shall conform to MIL-I-83446.

3.5.5.24.7 Variable inductors. When a roller or slider is used in contact with the conductor of variable inductors, suitable provision shall be made to limit the travel of the roller or slider to prevent its leaving the conductor.

3.5.5.24.8 Variable transformers. Variable transformers shall conform to MIL-T-83721, Class I or II.

3.5.5.24.9 The electrostatic shield. All power transformers shall have an electrostatic shield.

3.5.5.25 Wiring. The selection, application, and wiring practices for cable and wire shall be in accordance with the following subparagraphs:

3.5.5.25.1 Clearance and leakage (creepage) distances. Clearance between solder connections or bare conductors (such as terminal strips, stand offs or similar connections), shall not allow accidental contact occurring between adjacent connections when subject to service conditions specified in the equipment specification. (For electrical clearance and leakage distances, see Table VII.)

3.5.5.25.2 Impedance matching. Where rf cables are employed, equipment shall be designed to attain proper impedance matching with the cable and fittings.

3.5.5.25.3 Wiring protection. The wiring shall be secured and protected against chafing due to vibration or movement (such as slide out racks or drawers). For the securing of wiring, polyamide clamps or wrappings and tying devices with integral mounting facilities are preferred. Metal clamps, if used, shall be insulated. Individual conductors secured shall lie essentially parallel; however, this does not prohibit the use of twisted pairs.

3.5.5.25.4 Insulation cold flow. For insulated wire susceptible to cold flow, care shall be exercised so there will be no cold flow of the insulation.

the cable.

3.5.5.25.7 Sleeving. Flexible plastic sleeving, either nonflammable, self extinguishing, or flame retardant, shall be used on cables subject to flexing, such as panel door cables. The sleeving shall be secured under cable clamps at each end. The cable shall be formed and secured so the cable will not be subject to abrasion in its normal flexing motion. In cases where abrasion cannot be avoided, additional protection shall be provided.

3.5.5.25.8 Panel door cables. Wiring to parts on a hinged door shall be contained in a single cable, arranged to flex without becoming damaged when the door is opened and closed. However, if physical separation between wires is essential for electrical reasons, or where the number of wires involved makes a single cable impracticable, more than one flexible hinging cable may be employed.

3.5.5.25.9 Through hole protection. Whenever wires are run through holes in metal partitions, shields, and the like, less than 1/8 inch in thickness, the holes shall be equipped with suitable mechanical protection (grommet) of insulation. Panels 1/8 inch or more in thickness shall have either grommets or the hole edges rounded to a minimum radius of 1/16 inch. Grommets for wires operating at rf potentials exceeding 500 volts rms, shall be of ceramic or plastic material of suitable dielectric strength, except for coaxial cables which have outside protection, where rubber or neoprene is acceptable. Insulating grommets are not required for wires or groups of wires passing through shields or other metallic partitions where clearance can be maintained sufficiently to preclude the possibility of accidental contact or damage by abrasion.

3.5.5.25.10 Wiring arrangement. All wiring shall be arranged in a neat and orderly manner. The use of preformed cables and wiring harnesses is preferred to the point-to-point method of wiring. Wires shall be bundled and routed to minimize electrical coupling. Where practicable, sensitive circuits in a wire bundle or cable shall not be placed adjacent to a distributing circuit. Materials used for lacing, binding, sleeving, and strapping shall be selected from appropriate government specifications, be compatible with the conductor or cable insulation or jacket, and shall meet the same flame retardant and self extinguishing requirements. Wiring shall be arranged to permit bundling or permanently mounted in cable ducts. Minimum tape size shall be in accordance with Table VIII.

a. prevent undue stress on cable forms, wires and connections, including connections to resiliently support parts.

b. enable parts to be removed and replaced during servicing without disconnecting other parts.

c. facilitate field repair of broken or cut wires.

d. permit units in drawers and slide out racks to be pulled out to the limit of the slide or support travel without breaking connections. Units which are difficult to connect when mounted, shall be capable of movement to a more convenient position for connecting and disconnecting cables. When drawers or racks are fully extended and rotated (if rotatable), the cable bend radius shall not be less than three times the cable assembly diameter. When flat molded cable assemblies are used, the bend radius shall not be less than ten times the cable assembly thickness.

e. permit replacement of at least two of the particular parts to which the wire or cable is connected. The only exceptions to this provision are cases where rf leads must be as short as possible for electrical reasons and when fixed path rotating is specified or the amount of slack is limited by space available as occurs in automatic machine wired panels.

f. ensure freedom of motion of contacts or terminals normally intended to have some degree of movement (i.e., floating contacts in connectors).

3.5.5.25.13 Wiring in terminal boxes. Wiring and cables in terminal boxes shall be fanned out to identify terminals for check purposes if test points for required maintenance information are not provided.

3.5.5.25.14 Entrance cabling and wiring. Leads from cable entrances to terminal boards, plugs, jacks, and similar devices shall be harnessed and suitably clamped or supported in a cable duct. Flat cable may be used where suitable.

splices, bolted connections, then connectors when junctions are used. The choice of the listed junctions shall be determined by consideration of reliability factors, maintenance factors, and manufacturing procedures.

3.5.5.25.16 Support. Wire and cable shall be properly supported and secured to prevent undue stress on the conductors and terminals and undue change in position of the wire or cable during and after subjection of the equipment to specified service conditions, or after service or repair of the equipment in a normal manner. When shielding on wire or cable is unprotected by an outer insulation, adequate support is necessary to prevent the shielding from coming in contact with exposed terminals or conductors. Twine or tape shall not be used for securing wire and cable.

3.5.5.25.17 Cable and harness design. Cables and separable harnesses shall be of the two-connector type whenever possible. The two connectors shall be of the same number of contacts and all contacts shall be wired point-to-point (i.e., pin 1 to pin 1, pin A to pin A, or pin 1 to pin A and up in sequence). A minimum number of connector types and contact configuration within a type shall be used consistently with non-cross mating requirements, circuit and spare considerations.

3.5.5.25.18 Connectors, insulation sleeving. Unpotted connectors furnished as integral wired in parts of articles of equipment shall have a piece of insulating tubing placed over each wire in the connector. The tubing shall be long enough to cover the contact and have at least 1/2 inch of insulation of the wire attached to it; but in no case shall the length of the tubing exceed 2 inches. The minimum length of 1/2 inch may be reduced to 3/16 inch where restricted volume does not permit longer tubing (such as in miniaturized electronic subassemblies). The tubing shall fit tightly over the contact or be tied securely enough so that it will not slide off. If bare wire is used, the tubing shall be long enough to extend at least 1/4 inch beyond the contact, metal shell or clamp, whichever projects the furthest. This does not apply to connectors with body insulated crimp-on contacts, nor to wire wrapped connectors in accordance with MIL-STD-1130.

3.5.5.25.19 Fungus protection. Prior to attachment of terminals to prepared lengths of cables containing materials that will support fungus, the ends shall be protected against entrance of moisture and fungus by treatment with a fungicidal varnish conforming to MIL-V-173 and in accordance with MIL-T-152.

3.5.5.25.21 Aluminum conductors. Aluminum conductors shall not be used.

3.5.6 Mechanical parts.

3.5.6.1 Bearings. Bearings shall be in accordance with the following subparagraphs:

3.5.6.1.1 Lubricant. Adequate lubricant shall be provided either within the bearing or externally in the form of oil reservoirs or grease relubrication facilities except as noted herein. Where lubricant replenishment is required, precautions shall be taken to prevent purged or lost lubricant from entering and adversely affecting the operation of the equipment. Where bearings coated with preservative are installed in closed housings, the preservative shall be compatible with the lubricant used in the assembly.

3.5.6.1.2 Barrier coating. Bearings requiring a barrier coating shall be coated in accordance with MIL-STD-1334. Barrier coating material shall conform to MIL-B-81744.

3.5.6.1.3 Seals and shields. All rolling element bearings shall be adequately protected by seals or shields on the bearing or installed in housings which provide adequate shielding to prevent foreign matter from entering the bearing.

3.5.6.1.4 Self lubricating bearings. Permanently lubricated bearings or bushings of plastic, metallic-plastic combinations, or all metallic materials with or without dry film lubricants may be used provided wear products produced during operation will not cause or contribute to failure of the equipment or bearings.

3.5.6.1.5 Unlubricated bearings. Unlubricated bearings or bushings may be used only in applications where the presence of a lubricant would be undesirable or detrimental and the functional, environmental and service life requirements can be met in this condition.

3.5.6.1.6 Electrical grounding. Ball and roller bearings used for rotating an electrically energized equipment shall be electrically shunted to avoid current flow through the bearings.

3.5.6.1.7 Alignment. Bearings shall be located to ensure proper shaft alignment and support.

in such manner that the control position can be readily identified. Controls shall have fixed guide marks if presetting of the controls is required.

3.5.6.2.2 Arrangement and location. Controls shall be arranged to facilitate smooth and rapid operation. All controls which have sequential relations, and are related to a particular function or operation, or are operated together shall be grouped together along with their associated displays. Controls shall be conveniently located with respect to associated visual displays. Controls located adjacent to their associated displays shall be so positioned that operation of the control will not obscure the display. Controls shall be sized and spaced so the manipulation of a given control does not interfere with the setting of an adjacent control. Adjustment controls with required test points shall be grouped and marked to provide for simplicity and ease of maintenance. When the activation of a given control is hazardous to the equipment or operator, safeguards shall be provided.

3.5.6.2.3 Direction of movement. Controls shall be connected in the circuit so the controlled characteristics (e.g., sensitivity, volume, or voltage) increase with clockwise rotation of the control as seen from the operating position. Movement of a control forward, clockwise, right, or up, shall turn the equipment on, or cause the quantity to increase, the equipment to move forward, clockwise, to the right or up.

3.5.6.2.4 Operating controls. Controls necessary for the operation of the equipment shall be readily accessible, and shall be located on the front panel of the unit.

3.5.6.2.5 Adjustment controls. Adjustment controls that are required for periodic alignment or calibration shall be mounted behind covered openings (such as access doors), and on the faces of the equipment most accessible when installed. When not adjustable by hand, controls shall be designed to accept a common screwdriver blade tip. Controls which infrequently require adjustment need not be accessible from the operating panel, but shall be readily accessible for servicing when the equipment is opened for maintenance purposes.

3.5.6.2.6 Operation. Play and backlash in controls shall be held to a minimum commensurate with intended operational functions and shall not cause poor contact or inaccurate setting. Controls shall operate freely and smoothly without binding, scraping, or cutting. Controls may be lubricated when lubrication does not interfere with operation and is specified in the detail equipment specification.

3.5.6.2.8 Locking devices. Control locking devices shall retain the controls in any given setting within the range of control. The locking and unlocking action shall be easily and quickly accomplished, and shall not affect the setting of the control. When in the unlocked position, the locking devices shall not interfere with the normal operation of the control. Where vernier controls are used, the locking devices shall operate on both main and vernier controls if necessary to prevent damage.

3.5.6.2.9 Nonturn devices. All non-turning controls and bodies or cases of turning controls shall be equipped with a positive device to prevent their turning in the panel or in the assembly on which they are mounted.

3.5.6.2.10 Shafts and couplings. Control shafts and couplings shall be of design and strength commensurate with their respective loads. Coupling between or to shafts shall be accomplished by means of metallic or insulated couplings rigidly secured. Shafts subject to removal may have their couplings secured by two set screws 90 to 120 degrees apart. Flexible couplings will be permitted for controls where the use of rigid couplings would interfere with the satisfactory operation or mounting of such controls. Flexible couplings shall not be employed for frequency determining circuits.

3.5.6.2.11 Control knobs and handles. Control knobs and handles shall have high impact strength and shall be firmly secured to the control shafts by use of setscrews wherever that type of fastener is applicable. Plastic knobs and handles shall have metal inserts for setscrews and shall not warp or crack.

3.5.6.2.12 Multiturn counters control dials. Manually operated multiturn counter control dials shall conform to MIL-D-28728.

3.5.6.2.13 Stability. All controls shall be designed so the setting, position, or adjustment of any control shall not be altered when the equipment is subject to the specified service conditions.

3.5.6.2.14 Construction. Switches, levers, and other controls which are manipulated during operation of the equipment shall be of rugged design and construction so they will not be damaged when repeatedly operated by unskilled personnel under the specified service conditions.

3.5.6.2.15 Factory adjustment controls. The design of equipment shall not include "factory" or sealed adjustment controls.

fastener will not free the part completely. Friction between mating surfaces shall not be employed as the sole means of preventing fixed parts from rotating or shifting. For critically stressed applications, suitable torque values for screw thread assemblies shall be established. Torque measuring or controlling devices shall be used for tightening the threaded parts.

3.5.6.3.2 Mounting and assembly. The mounting or assembly of parts shall be accomplished by one of the following means:

a. A through-screw secured by a self-locking nut or plain nut and lock washer. When frequent assembly/disassembly are anticipated (more than 15 times), a plain nut and lockwasher shall be used.

b. A through-screw secured by a plain nut, with a sealant applied to the threads of the screw and nut.

c. A screw into a threaded bushing (in a staked, clinched, pressed-in nut; or an insert). The bushing, nut, or insert shall be secured to the structure.

d. When an externally threaded fastener must be screwed into an aluminum alloy part and the parts must be frequently disassembled in service, the aluminum alloy parts shall be provided with inserts of corrosion-resistant steel or other suitable material. Threaded holes in plastic material, when used with externally threaded fasteners, shall be provided with suitable metallic inserts.

e. A screw in a tapped hole, with a sealant applied to the threads of the screw.

f. A stud in a tapped hole.

g. A self-locking screw in a hole tapped into the hard material.

h. Self-tapping screw into the hard material when used within the limitations of paragraph 3.5.6.4.5.

3.5.6.3.3 Fastening of brittle materials. Brittle castings or parts made of ceramic or other brittle material shall be properly cushioned to prevent breakage. Washers or gaskets of suitable material and compressibility shall be used between the otherwise facing surfaces of the brittle part and other

Threaded holes in ceramic material shall be avoided for assembly or mounting of parts.

3.5.6.3.5 Locking devices. All threaded assemblies shall be vibration and shock proof. Fiber inserts shall not be used as locking devices. Castellated nuts with cotter pins are acceptable.

3.5.6.3.6 Stud-mounted. Self-locking nuts shall be avoided on stud-mounted components unless the stud material is compatible with the strength or material of the nut used.

3.5.6.3.7 Application without nuts. In applications requiring the use of bolts or screws without nuts, one of the following locking devices or methods shall be used:

a. Lockwashers under the heads of the bolts or screws.

b. Self-locking screws.

c. Self-locking thread inserts.

d. A locking or retaining compound applied to the threads.

e. Safety wire through drilled heads.

3.5.6.4 Threaded Fasteners. Threads shall be in accordance with FED-STD-H28 or MIL-S-7742. Where threaded fasteners are required to mate with, or to mount threaded commercial equipment or devices, threads shall be in accordance with FED-STD-H28. Threads shall be in accordance with MIL-S-8879 for applications requiring high stress or high fatigue life. Caution shall be exercised where a MIL-S-8879 UNJ external thread fastener is used due to its incompatibility with the commonly used UNC, UNF, or UNEF threaded nut or tapped hole. The use of threaded fasteners made of aluminum alloy or magnesium to mate with threaded parts of aluminum alloy or magnesium shall be avoided. Where such is required, an antiseize compound shall be used to prevent seizing of the threads.

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3.5.6.4.2 Nuts. Nuts shall be preferably of the hexagon style with the following exceptions:

a. Nuts used in conjunction with a mechanical means to prevent rotation, press-type nuts, i.e., gang channel nuts, floating and self-aligning plate nuts, clinch-type or press nuts.

b. Plate nuts of the lug style which are generally riveted or spot-welded to sheet structure.

c. Nuts designed for a specific purpose, e.g., nuts for honeycomb structure.

d. Sheet spring nuts shall not be used without specific approval of the procuring activity.

3.5.6.4.3 Self-locking nuts. Self-locking nuts shall conform to MIL-N-25027. Self-locking nuts shall not use fiber inserts as the locking device.

3.5.6.4.4 Thread-forming, thread-cutting, and drive screws. Thread forming, thread-cutting, and drive screws shall not be used except as follows:

a. For the permanent attachment of name plates to sheet metal where it is practicable to extrude the hole permitting a minimum 1/8-inch full-thread engagement.

b. With the specific approval of FAA, thread-forming screws may be used on equipment to be installed in a static (fixed station) environment for low-stress applications where disassembly is not normally anticipated.

c. For the permanent attachment of nameplates to material having nominal thickness of 1/8-inch or greater.

3.5.6.4.5 Thread engagement. Highly stressed applications, screws or bolts shall have a minimum thread engagement of 1-1/2 times their nominal diameter in tapped parts other than nuts. In normal applications, screws or bolts shall have a minimum engagement length equal to their nominal diameter in tapped parts other than nuts. When the assembly is not frequently

length shall be limited by the nearest larger standard screw length. These rules apply except when such projection will result in corona discharge or when design requirements cannot be met.

3.5.6.5 Rivets. Rivets shall be used in preference to other hardware for securing parts not requiring removal when the equipment is serviced. Rivets shall not be used for mounting items normally subject to replacement, such as capacitors, resistors, transformers, or inductors. Wherever the thickness of metal which accepts the heads of flush rivets is less than the height of the rivet heads, the material shall be dimpled rather than countersunk. The distance from the center of rivet holes to the edges of the material in which the rivets are placed shall not be less than 1-1/2 times the rivet diameter. Rivets for joining magnesium parts shall be composition 5056 anodized aluminum alloy or an aluminum alloy having equal galvanic compatibility with the magnesium.

3.5.6.6 Other Hardware.

3.5.6.6.1 Insert. Inserts shall be constructed so they will not loosen when tightening or loosening the screw or stud. External threaded inserts shall be capable of being replaced with inserts which have identical internal threads.

3.5.6.6.2 Flat washers. Flat washers shall be used for the following applications:

a. Between screw heads and soft materials, unless a washer head screw, or similar type that provides a bearing surface equivalent to the bearing surface of the appropriate flat washer, is being used.

b. Between a nut or lockwasher and a soft material.

c. Where lockwashers are used for securing a safe material, a flat washer shall be provided to prevent marring or chipping of the material or the applied protective coating, except in areas where an electrical ground is required.

d. Except where it conflicts with electromagnetic interference considerations, a flat washer shall be used between an organically finished material and lock-washers, bolt and screw heads, or nuts.

subject to embrittlement relief test. Tin plating in accordance with 3.7.6.3.4 may be used in lieu of cadmium plating if soldering to the part is required. Standard MS or AN parts with other suitable finishes do not require refinishing.

3.5.6.7.1 Dry film lubrication. For dry-film lubricated nuts, the type and class of plating are optional if the nuts conform to the salt spray requirements for type II plating in accordance with QQ-P-416.

3.5.6.7.2 Other materials. Other materials may be used where uniquely required by the design of the equipment. Materials shall not be used which take a permanent set under normal conditions of stress.

3.5.6.8 Safety wiring and cotter pins. Application of safety wiring and cotter pins shall conform to MS33540. Safety wiring and cotter pins shall not be used on terminals such as screws and threaded studs required to function as electrical terminals.

3.5.6.9 Gears and cams.

3.5.6.9.1 Design. The design of a gear train shall be such that the gear train system shall meet performance requirements throughout its specified life.

3.5.6.9.2 Criteria. Gears shall be designated, dimensioned, toleranced and inspected in accordance with American Gear Manufacturers Association (AGMA) specifications.

3.5.6.9.3 Preferred gearing. Planetary or epicyclic gearing is preferred to worm gearing.

3.5.6.9.4 Nonlubricated. Gears not operating in a lubricant bath shall be made of corrosion resistant materials.

3.5.6.9.5 Lubricated. Gears operating in a lubricant bath enclosure may be made of noncorrosion resistant materials. The lubricant shall have a corrosion inhibiting additive.

3.5.6.9.6 Nonmetallic gears. Nonmetallic gears may be used when they meet load, life, and environmental requirements of the applicable specification. Nonmetallic gears shall be limited to nylon and polytetrafluorethylene.

considered only when the required function cannot be provided by an existing standard tool. Necessary tools shall be identified as early as possible. The need for any special tool shall be subject to the approval of FAA.

3.5.6.10.2 Furnishing and stowing. Special tools needed for operation and maintenance shall be furnished by the contractor and shall be mounted securely in each equipment in a convenient and accessible place, or in a central accessible location for an equipment array requiring such tools.

3.5.6.10.3 Tool life. Special tools shall be capable of performing the required functions throughout the life of the equipment they support.

3.5.6.11 Springs.

3.5.6.11.1 Fatigue limits. Electrical conductivity of contact springs shall not be adversely affected by corrosion, operating temperature, and other environmental conditions in service. Fatigue limits shall be consistent with the maximum specified operating cycles for the respective part or equipment or, if such is not specified, with the maximum duty cycle expected during the equipment service life, so as to ensure against premature failure.

3.5.6.11.2 Design. Springs shall be enclosed or captivated to prevent parts from becoming adrift if broken.

3.5.6.11.3 Heat treatment. Springs made of materials that achieved their desired properties by heat treatment (such as copper-beryllium alloys, annealed carbon steels, CRES steels, or heat resisting alloys), shall be heat treated to the specified temper after forming.

3.5.6.11.4 Grain orientation. Flexure and forming of spring elements shall be designed to occur perpendicular to the grain of the material. Deviation from the perpendicular shall not exceed 45 degrees. This requirement applies to springs whether heat treated or not.

3.5.6.11.5 Finishes. Carbon steel springs shall be suitably plated or finished to resist corrosion.

3.5.6.12 Tuning dial mechanisms.

3.5.6.12.1 Dials. Dial markings shall be legible at a distance of two feet from any point within a solid angle of 60 degrees defined by a surface of

3.5.6.12.2 Balance and friction. Weighted tuning knobs shall be counterbalanced. Friction in tuning dial mechanisms shall allow smooth and easy adjustment of the operating knob over the entire operating range of the mechanism, but shall have sufficient resistance or shall incorporate a positive locking device to maintain the setting under all specified service conditions. Friction shall be achieved through dry or elastic resistance rather than by fluid resistance.

3.5.6.12.3 Flexible control shaft. Flexible shaft assemblies conforming to MIL-S-3644 shall be used when a flexible mechanical connection is required between the tuning knob and the tuned device.

3.5.6.12.4 Tuning ratio. The tuning ratio used shall be the optimum which will permit both rapid and precise setting.

3.5.7 Miscellaneous items.

3.5.7.1 Gaskets. Gaskets for windows, access doors, and covers shall be of synthetic rubber conforming to MIL-G-1149. Gaskets shall be installed on both sides of windows and shall provide the same degree of enclosure as the housing to which they are secured. The gaskets for access doors and covers shall be cemented or otherwise fixed in place to prevent displacement when such doors or covers are opened or removed. Selection shall include EMI/RFI requirements, as applicable.

3.5.7.2 Glass. All glass used in the equipment shall be of the shatterproof type in accordance with Class 1, Type I, or Class 2 of Specification MIL-G-3787.

3.6 Materials.

3.6.1 Adhesives. Adhesives shall be resistant to swelling or other deterioration caused by contact with air, moisture, fungus, gases, ozone, or solvents which will be encountered in use. Adhesives which are not compatible structurally shall be avoided. For example, a brittle adhesive shall not be used for glass bonding because excessive shrinkage during setting or curing will load the glass in tension. For assemblies which may be flexed or subject to impact, a brittle adhesive shall not be used.

consideration should also be given to their electrical and thermal characteristics when subjected to the specified conditions.

3.6.3 Dissimilar metals. Selection and protection of dissimilar metal combinations shall be in accordance with MIL-STD-889. Where electronic design requirements preclude the insulation of incompatible metal combinations as identified in MIL-STD-889 from one another, specific attention shall be paid to isolating the combination from exterior environments.

3.6.4 Ferrous alloys. Ferrous alloys shall be corrosion-resisting types or shall be suitably protected to be capable of withstanding a salt spray test for a minimum of 48 hours in accordance with FED-STD-151. Where cleaning operations on metal parts are not specified in detail, they shall be in accordance with the best commercial practices which will not cause subsequent corrosion that interfere with the mechanical or electrical performance.

3.6.4.1 Selection.

3.6.4.1.1 Corrosion-resisting ferrous alloys. Austinitic corrosion-resisting steel shall be used for all structural parts which will be subjected to severe corrosive conditions, such as exposure to sea water and combustion gases.

3.6.4.1.2 Iron and steel. The use of iron or steel shall be kept to a minimum commensurate with strength requirements. Where closures, cases, frames, panels, brackets, and miscellaneous hardware are fabricated of steel, such material shall be treated to prevent corrosion.

3.6.4.2 Corrosion protection.

3.6.4.2.1 Corrosion-resisting steels. Corrosion-resisting steels shall be given a passivation treatment. Other protective finishes or platings are permitted for electrical or mechanical reasons. (See 3.7.6).

3.6.4.2.2 Iron and steel. Ordinary iron and steel shall be plated or finished to resist corrosion, except for the following conditions:

a. Iron or steel lamination used in magnetic circuits which are otherwise protected against corrosion.

b. Ferrous metal mechanisms that are bathed in oil or packed in grease, potted, or hermetically sealed, shall not require protective coatings.

not have such a test, materials shall be tested in accordance with ASTM D568 or ASTM D635. Pressure sensitive adhesive tapes shall be tested in accordance with the flammability test in ASTM D1000.

3.6.6.2 Materials. Materials not covered by the test above shall be tested in accordance with a procedure proposed by the manufacturer and approved by FAA.

3.6.6.3 Additives. Additives shall not adversely affect the specified performance requirements of the basic materials. Fire retardance shall not be achieved by use of nonpermanent additives to the basic material.

3.6.7 Fungus-inert materials. For new designs, only inherently fungus-inert materials shall be used except other materials may be used in hermetically sealed assemblies or other specifically approved items. For reprocured equipment, if it is necessary to use nutrient materials in other than the above approved applications, they shall be treated by a method that will render the exposed surface fungus-resistant so that they will pass the test of 3.6.7.2. When materials are compounded with a permanently effective fungicide in order to pass the fungus test, there shall be no loss of the original electronic or physical properties required by the basic materials specification.

3.6.7.1 Fungus susceptibility. Group I in Table IX lists those materials which are considered not to be nutrient to fungi in all modified states and grades. Group II lists materials which are not fungus-inert in all grades and therefore the fungus resistance of the materials selected shall be confirmed by testing as specified herein.

3.6.7.2 Fungus testing. Group II and treated materials selected for other than approved applications shall pass the fungus test specified in ASTM G21. There shall be no visible growth of fungus after 28 days. Certification by a qualified laboratory or by the material producer, based upon test data on record and the selected material passed the above test, will be sufficient evidence of acceptability.

3.6.7.3 Nonplastic materials. All nonplastic materials to be tested for fungus-susceptibility, such as paint, ink, coatings, adhesives, lubricants, rubber, viscous damping fluids, silicone grease, etc, shall be prepared in the form of 2-inch squares or circles no more than 1/16-inch thick for testing. Liquid or paste materials shall be prepared by impregnating to saturation a sterile sample of glass fabric.

a. Temperature endurance.

b. Moisture absorption and penetration.

c. Fungus resistance.

d. Dielectric strength.

e. Dielectric constant.

f. Mechanical strength.

g. Dissipation factor.

h. Ozone resistance.

3.6.8.2 Insulation classes. The insulation used shall be of such a class as to meet the temperature extremes to which it may be subjected, as specified in the detail equipment specification. Insulation classes and the maximum hotspot temperatures for continuous operation are as follows:

a. Class A - 105°C maximum

b. Class B - 130°C maximum

c. Class F - 155°C maximum

d. Class H - 200°C maximum

e. Class C - Above 200°C.

3.6.8.3 Electrical tape. Cotton and linen tapes shall not be used.

3.6.8.4 Sleeving. Sleeving shall provide adequate dielectric strength and leakage resistance under the designated service conditions.

3.6.8.5 Plastic materials, general. Plastics used for electrical insulating parts shall combine properties of flame resistance, arc resistance, and low toxicity with good electrical and mechanical properties. Plastic parts shall retain the original smooth or polished surface unless objectionable or functional requirements make a dull surface more desirable. If necessary for

moisture resistance with a suitable material after all machining and punching operations have been completed. Materials having moisture absorption of 1.0 percent or less, and those used in hermetically sealed containers, need not be treated. Cotton or linen shall not be used as the base or filler for any laminated plastic requiring electrical properties. The preferred base is glass cloth.

3.6.8.7 Plastic, thermosetting, molded. Molded parts which undergo subsequent machining shall be vacuum impregnated with a suitable material and dried after all surface-breaking operations have been completed. Cotton and linen shall not be used as filler material in any electrical insulator. Materials having moisture absorption of 1.0 percent or less, and those used in hermetically sealed containers, need not be impregnated.

3.6.8.8 Varnish, insulating. When used for impregnation, insulating varnish shall be handled by a method which will insure removal of all air and water and insure a complete fill.

3.6.8.9 Wire insulation. Wire insulation with cotton or linen in its construction shall not be used, except when the wire is used for coils on forms, and then only if the insulation on the wire is completely sealed off from the atmosphere.

3.6.9 Lubricants. Lubricants used in equipment shall be suitable for the purpose intended.

3.6.9.1 Variety. The number of different lubricants shall be held to a minimum.

3.6.9.2 Volatility. Low volatile lubricants shall be used where practical.

3.6.9.3 Compatibility. The lubricant shall be chemically inert with regard to the materials it contacts.

3.6.9.4 Silicones. Silicone compounds shall not be used as lubricants.

3.6.9.5 Graphite base lubricants. Graphite base lubricants shall not be used.

3.6.10 Rubber (natural). Natural rubber shall not be used.

3.6.11 Wood and wood products. Wood and wood products shall not be used.

b. not be used where failure of the compound would endanger personnel or damage the equipment.

c. be compatible with the material and finish to which they are bonded and shall have no detrimental effect on the material or finish.

d. not cause or accelerate corrosion.

3.6.13 Antiseize compounds. Antiseize compounds shall conform to MIL-T-22361 or TT-S-1732. Graphite base antiseize compounds shall not be used.

3.7 Processes.

3.7.1 Brazing. Brazing shall be in accordance with MIL-B-7883. Electrical connections shall not be brazed.

3.7.2 Castings.

3.7.2.1 Die castings. Die castings shall not be used where the casting might be subject to impact. Zinc alloy die castings shall not be used where dimensional changes of the casting could affect use of equipment.

3.7.2.2 Inserts. Inserts intended to be cast in place shall be knurled, grooved, or otherwise prepared to secure satisfactory keying of the insert too adversely affected by exposure to the molten casting alloy. When inserts are located near a casting edge, sufficient edge distance shall be allowed in order to develop the required resistance to insert pull-out, and to avoid cracking of the casting. Casting defects resulting from use of inserts, such as partial alloying, poor bonds, porosity, and cracks shall not be present.

3.7.2.3 Porous castings. When required, castings shall be impregnated in accordance with MIL-STD-276.

3.7.2.4 Classification and inspection. Castings shall be classified and inspected in accordance with MIL-STD-2175.

3.7.3 Encapsulation and embedment (potting). The encapsulation and embedment materials shall be selected on the basis of the item(s) being encased. The

deleterious effect on the part or assembly to which they are applied. The materials shall be contained, if necessary, to prevent flow or cracks under the specified storage or operating environment.

3.7.3.2 Application. No encapsulation or embedment materials shall be applied to an individual part except as part of the controlled production process for that part. The encapsulation or embedment of microelectronic modules and equipment modules shall be avoided, except where specifically indicated by the requirements of a particular application. In such instances, the module design shall be completely verified for the particular encapsulation or embedment materials and processes to be employed. Any changes in module design, materials, and processes will require re-evaluation of the modules. In particular, extreme temperature aging and temperature cycling tests shall be performed to verify adequacy of the design. Wherever economically feasible, the module to be encapsulated or embedded shall be designed as a throw-away unit.

3.7.4 Welding, structural. The joint areas of all parts to be welded shall be cleaned of contaminants and materials which may be detrimental to obtaining satisfactory welds. The fusion, penetration, and size of the weld shall be sufficient to meet the design requirements. Degradation of material properties in the heat affected zone caused by welding shall be considered. Weldments shall be stress relieved when induced stress resulting from welding, design configuration, or materials welded may be harmful. (See AWS A2.4 for welding symbols, AWS A3.0 for welding terms and definitions, and MIL-STD-22 for welded joint designs.)

3.7.4.1 Arc and gas welding. Welding by arc and gas methods shall be performed by operators who have passed the applicable certification tests and have a certificate of proficiency in accordance with MIL-STD-248 or MIL-STD-1595. Electrodes used in arc welding shall be of the type that will produce a weld having chemical and physical properties similar to those of the parent metal. For the materials indicated, welding shall conform to the following specifications:

a. Welding of aluminum alloys: MIL-W-8604

b. Welding of magnesium alloys: MIL-W-18326

c. Welding of steel alloys: MIL-W-8611.

3.7.4.3 Noncritical applications. For those applications, if the weld should fail, and it will not compromise personnel or equipment safety or prevent completion of the mission, then welding procedures in accordance with MIL-STD-1261 may be used.

3.7.4.4 Other methods. Other welding methods, such as the electron beam process (MIL-W-46132), may be used provided approval is obtained from FAA.

3.7.5 Welding, electrical and electronic interconnections. Electrical interconnection resistance welds shall be in accordance with MIL-W-8939.

3.7.5.1 Electrical connections. Except where needed to meet electromagnetic interference or system compatibility requirements, welded electrical connections shall not be used where it may be necessary to disconnect, replace, or reconnect a part or module during servicing.

3.7.5.2 Excess conductor wire. Excess conductor wire shall be trimmed sufficiently close to provide adequate clearance and prevent possible electrical shorting but not so close as to cause damage to the weld joint.

3.7.5.3 Strain relief. Each part lead terminating at a connection point shall have allowance for strain relief to minimize tensile or shear stress.

3.7.6 Equipment finish. For equipment that is to be operated within a facility, the surfaces shall be given a protective finish as specified in the following subparagraphs:

3.7.6.1 Painted finish. Metal surfaces not otherwise protected as described herein shall be painted in accordance with FAA-STD-012 and the following:

3.7.6.1.1 Exposed metal surfaces. The exposed surfaces of the equipment shall be finished of a baked on lusterless alkyd enamel having a smooth matter texture. The color shall be brown in accordance with FAA-STD-001.

3.7.6.1.2 Interior metal surfaces. The interior surfaces shall be finished in one of the following ways; same as exposed surface, or with a baked primer (only) which is the same color as the exposed surface but not necessarily closely matched thereto, or with a durable coating of light gray enamel.

shall be equal to the best commercial grade, using plating thicknesses adequate for protection of the parts under conditions of their use in service. Flash platings, platings with base metals or underplatings showing through, or platings which are pitted or give evidence of flaking or peeling, are not acceptable. The type of platings which shall be used on specified base metals are as follows:

Base Metal	Plating Requirements
Monel	None; smooth finish free from discoloration.
Stainless steel	Passivation treatment after machining; smooth finish free from discoloration
Ferrous metal	Exterior hardware; bright chromium over nickel copper Interior hardware; zinc, or white chromium over nickel and copper, or white or bright cadmium.
Copper, Brasses, Bronzes	Exterior hardware; bright nickel or chromium. Interior hardware; white or bright nickel or chromium. Other parts; white or bright nickel, chromium, tin or cadmium.

3.7.6.3.1 Cadmium plating. Cadmium plating shall not be used if it is in direct contact with, or located in confined spaces adjacent to waxes, phenolics, or other organic materials which will react with the cadmium to cause "growth" or the formation of cadmium soaps. Cadmium plating shall be in accordance with Type II, Class 1 of QQ-P-416 plating with the following exceptions:

a. Bolts, studs, washers, nuts, and articles with portions externally threaded. These parts have a minimum of class 3 thickness.

b. Parts whose dimensional tolerances will not permit a class 2 thickness shall be given the maximum thickness of plating compatible with dimensional tolerances.

necessary in cadmium-plated parts.

3.7.6.3.2 Zinc and zinc-plated parts. Zinc and zinc-plated parts shall be given a dichromate treatment in accordance with ASTM-B-633.

3.7.6.3.3 RF conductivity platings. Silver electroplating may be used where required because of the considerations of conductivity. Silver plating shall be in accordance with QQ-S-365, with a minimum thickness of 0.0005 inch.

3.7.6.3.4 Tin plating. Tin plating shall be in accordance with MIL-T-10727.

3.7.6.4 Corrosion-resisting treatments. Corrosion-resisting treatments shall be applied after all fabricating operations (such as welding and machining), have been completed. The corrosion-resisting treatments and metallic coatings shall be in accordance with the applicable portions of MIL-S-5002.

3.7.6.5 Masking. Masking or equivalent means shall be employed where necessary to insure continuity of electrical contact with metallic mounting surfaces, chassis, parts, etc., assembled against the back surface of the panel or panel door.

3.7.7 Wire wrapped solderless connections. Solderless wrapped wire connections (wire wrap or backplane) shall be in accordance with MIL-STD-1130. FAA approval is required for specific design use.

3.8 Reference designations. Reference designations shall be assigned (and marked) in accordance with ANSI 200-75, except modified as follows:

a. Paragraph 4.1.5.5, third paragraph, line 5; delete "may" and substitute "shall."

b. Delete text of paragraph 4.1.8 and substitute "If a part serves a function other than the function for which it is designed, or a dual function, it shall nevertheless be represented on the schematic diagram by the graphic symbol and reference designation (latter chosen from Section 22 of ANSI 315-75) indicative of the physical characteristics of the part. Where space permits, the special function shall be noted on the diagram; in any case, it shall be described in the instruction book for the equipment.

3.9.1 Visibility of parts labels. All parts which have labels or markings carrying identifying data or ratings should be mounted so that the data are visible to maintenance personnel without the necessity for disassembly of part or of adjacent functional or structural parts. This requirement shall be mandatory whenever it can be applied by the contractor without purchasing made-to-order parts with special markings, and where it can be applied without preventing the use of normally compact assemblies of parts on chassis, such as side-by-side mounting of metal-cased capacitors, or other normal methods of assembly.

3.9.2 Other parts markings.

3.9.2.1 RF connectors. All rf connectors furnished on the equipment for the purpose of making external connections shall be clearly identified on the plug-in side by work labels descriptive of their specific functions (e.g., ANT, IF INPUT, RF OUTPUT, etc.).

3.9.2.2 Ferrule-resistor positions. All ferrule-resistor positions shall be marked to indicate the ohmic value of the resistor required for the particular position or mounting.

3.9.2.3 Other ferrule-mounting parts. Other parts with ferrule ends, such as, semiconductor rectifiers and vacuum capacitors are mounted in fuse clips, and polarity markings shall be provided where applicable.

3.9.2.4 Fuse positions. All fuse positions shall be marked with the rated current capacity of the fuse to be employed therein. Fuse positions for delayed-action fuses shall have the additional designation SLOW. The markings shall be on the insertion side, so as to be visible when replacing fuses.

3.9.2.5 Terminal strips and blocks. The terminals of all terminal strips and blocks, including those which are used for movable links or other adjustable circuit jumpers, shall be identified by numerals or other designations located immediately adjacent to the respective terminals, and marked directly on the terminal strip, block, or immediately adjacent thereto.

3.9.2.6 Wafer switches. Markings or other means of identification shall be provided on the equipment to enable a technician to identify the physical locations of wafer switch contacts for circuit tracing purposes.

relationship to the respective designated items.

3.9.2.8 Polarized parts. Where mounting arrangements for polarized parts are such that it would be possible for a replacement part to be mounted with terminal positions misplaced or reversed (as in the case of polarized capacitors, diodes or transistors, microelectronics, relays, connectors, transformers) polarity markings shall be provided on the mounting structure of the equipment, located and oriented so that the symbols can be clearly associated with the physical location of the connection points. Devices in the listing below shall have the specific markings indicated:

a. Diodes: The schematic graphical symbol (as used on instruction book diagrams).

b. Transistors and other semiconductor devices having three or more leads: The schematic graphical symbol wherever marking space permits, otherwise identifying letters (such as E, B, C for transistors) or a physical symbol (such as a notch, hole or shape).

c. Polarized capacitors and other devices with + and - terminal markings: + -.

3.9.2.9 Other electrical parts. On subminiaturized assemblies, transistors, integrated circuits, printed boards or other forms of assembly where space is at a premium, the reference designation need not be marked. In lieu thereof, reference designation marking shall be shown by means of pictorial diagram, line drawings, photographs or other media to provide for circuit identification (by means of reference designations) appropriate for the equipment.

3.9.2.10 Nonelectrical parts. The reference designation for each nonelectrical part, except screws, nuts, washers, bushings, pipe fittings and similar small hardware, shall be marked on the chassis, frame, panel, etc., immediately adjacent to the part. If space is not available, the reference designation shall be marked on the part itself.

3.9.3 Panel markings. The visible surface adjacent to panel facilities such as connectors, controls indicators, jacks, keys, switches and fuse holders shall be marked with a suitable word, phrase, or abbreviation, indicating the use or purpose of the part. These markings shall be legible so that the function of the panel facility can be identified by the operator.

nameplates (paragraph 3.10), shall be in accordance with MIL-P-15024. Unless otherwise specified in the equipment specification, the contractor shall obtain FAA approval prior to installation.

3.9.3.2 Markings on the panel surface. One of the following processes shall be used:

a. Engraving through the paint and then filled with contrasting color enamel.

b. Markings by epoxy ink process.

3.9.4 Interior marking methods. Markings on the interiors and rear surfaces of equipment shall be made by one of the following methods, using white markings on dark surfaces and black markings on light surfaces to provide maximum readability:

a. Engraving through paint, or on unpainted surfaces; contrasting color engraving wax or enamel shall be used as a filler except where contrast without filler provides adequate readability.

b. Silk screen process.

c. Stenciling.

d. Individual designation plates in accordance with MIL-P-15024.

3.9.5 Information required on equipment. The contractor shall mark the following on each piece of equipment having an FAA nameplate using a rubber stamp or equivalent means of marking:

Warranty: Yes_____ No_____

DATE FACTORY TEST COMPLETED_____

DATE ACCEPTED_____

DATE INSTALLED_____

IF WARRANTY APPLIES SEE INSTRUCTION BOOK

3.9.5.2 Location of stamping. The stamping shall be located on the back side of the front panel door, unless required space is not available, in which case the stamping shall be located on the rear vertical surface of the chassis. In case space is not available in either location, or where construction differs from that described above, the contractor shall obtain Government approval of the proposed location before stamping the equipment.

3.10 Nameplates. Each equipment furnished shall have one or more nameplates as determined by the equipment configuration. Each nameplate shall be in accordance with FAA Drawing C-21216, see Figure 1.

3.10.1 Equipment titles. Unless specifically set forth in the equipment specification, the contractor shall request titles and type designations before preparing and submitting the nameplate drawings to the Contracting Officer. The titles of the equipment specifications shall not be assumed to be the correct equipment titles for use on the nameplates.

3.10.2 Serial numbers. Serial numbers shall start with (1) one for each equipment unit having an individual nameplate and continue consecutively up to the total number of such equipment units on the contract.

3.10.3 Installation. FAA approval shall be obtained prior to installation of the nameplates.

3.11 Workmanship. Workmanship shall be in accordance with the requirements of this specification and the requirements of the specifications herein.

4.2 Contractor's detailed list of tests. A list of proposed tests shall be prepared as a means of proving compliance with the performance requirements of the equipment specification. This list shall identify all detailed tests to be performed and shall be submitted to the Government for formal review and approval. All test procedures shall reference the specific specification paragraph number being demonstrated. In addition to the proposed tests, the list shall include the tests of 4.3 unless they are specifically excluded in the equipment specification or contract schedule. This list shall be broken down into design qualification tests (4.3.2), type tests (4.3.3), and production tests (4.3.4), with appropriate use of steps a to i of 4.11 herein, also line voltage variations, to prove compliance under 3.3.4 herein (also see 4.8 through 4.10 herein). Where applicable, the FCC acceptance tests (4.3.5) and the reliability-maintainability demonstration tests (4.3.6) shall be included in the list of tests.

4.2.1 Submission of test documentation. Submission for approval of test data shall be as specified in FAA-STD-013, FAA-STD-016, or the contract schedule.

4.3 Classification of tests. Five classes of tests are required, as follows:

a. Contractor's Preliminary Tests (4.3.1)
b. Design Qualification Tests (4.3.2)
c. Type Tests (4.3.3)
d. Production Tests (4.3.4)
e. FCC Type Acceptance and Registration Procedures (4.3.5)

When specified, reliability and/or maintainability demonstration tests (4.3.6) shall be conducted in accordance with the approved Reliability/Maintainability Program Plan which details how reliability/maintainability requirements will be met.

4.3.1 Contractor's preliminary tests. Prior to notification of the Government that the initial production equipment is ready for inspection and readiness for inspection is demonstrated, one complete set of all tests required by the equipment specification and this general specification shall be made available to the Government. These preliminary tests shall be made on one production equipment or on one prototype (preproduction) model. Preliminary tests do not constitute any of the regular design qualification tests, type tests, reliability-maintainability tests, or production tests (nor FCC Type Acceptance and Registration Procedures tests where applicable under 3.3.1.1) required by the equipment specification or by this general specification.

4.3.1.2 Notification of readiness for inspection. After submission of the preliminary test data, and one or more production equipments are completed (i.e., equipments produced to meet all specification requirements), the Government Contracting Officer shall be notified in writing of the readiness for Government Inspection. Such notification shall be given in time to reach the Contracting Officer not less than five work days before inspection is to start.

4.3.2 Design qualification tests. The following tests (and verification) shall be made once, prior to, or concurrent with the first type test, on regular production equipment selected by the Government Representative.

a. Rating verification, parts and materials (4.3.2.1)

b. Other general specification tests (4.3.2.2)

c. Design qualification tests specified in the equipment specification

4.3.2.1 Rating verification, parts and materials. Measurements, calculations, or both, shall be made in order to establish that the parts (see 3.5) and insulating materials (see 3.6) used in the equipment will not be subjected to voltages, currents, power dissipation, and temperature, in excess of the derated values permitted by applicable specification requirements and this specification. All power supplies over 600 volts which are potted or encapsulated shall be subjected to a 48 hour heat run with all critical internal components instrumented to insure that proper temperature derating has been incorporated in the design. The instrumented heat run shall be performed with the power supply operating in the equipment in its final configuration location. Upon request by the FAA, at the inspection location specified in the contract, any rating verification, parts and material data requested shall be made avaiable to review adequacy of measurements or calculations.

4.3.2.2 Other general specification tests. Tests shall be made once, prior to, or concurrent with the first type test on regular production equipment to establish that the requirements of Table X are being met.

specification, or both. In the absence of specific requirements in the contract schedule or the equipment specification, the following subparagraphs apply:

4.3.3.1.1 Identification. The equipment on the contract shall be assigned sequential numbers in order as they reach the stage of completion and readiness for testing. Using these sequential numbers, the equipment shall be divided into groups for type testing as shown in Table XI. One type test shall be performed for each type test group. (The essential characteristic of any type test group must be homogenity.) With the exception of Type Test No. 1, selection of an equipment for type test within the group shall be made by the FAA representative.

4.3.3.1.2 Release to final inspection. Unless otherwise specified in the equipment specification, when the type test is successfully completed, the equipment in the group from which the type test equipment was taken is released for final inspection and subsequent shipment. The equipment in the next succeeding type test group are released for inspection and production testing only. If it is the last type test group, successful completion of type test releases all remaining equipment for final inspection and subsequent shipment.

4.3.3.1.3 Anomalies. If a type test is not successfully completed and requires parts or design changes or both in order to meet the specified type test parameters:

a. These parts, or design changes, or both, shall be incorporated in the group from which the type test equipment was taken, and all equipments retested to the extent determined necessary by FAA, prior to final inspection, acceptance or delivery.

b. A plan, acceptable to the Government, for the correction/ modification of previously accepted and delivered equipments in accordance with applicable contract warranty provisions and the requirements herein shall be proposed. For field modifications, the necessary parts, instructions and instruction manual revisions in accordance with FAA Order 1320.33B "Equipment Modification and Facility Instruction Directives" shall be provided.

to the FCC type acceptance and registration procedures in accordance with FCC Rules and Regulations: Part 2, and Part 68. The environmental temperature range specified by the FCC shall supersede, for the purposes of the FCC Type Acceptance Procedures, the service conditions temperature range which is applicable under the equipment specification and this specification. In addition, during the life of the contract, compliance shall be maintained with FCC Regulations in connection with any approved changes made to the production equipments which are relevant to the FCC Type Acceptance or Registration.

4.3.5.1 FAA acceptance contingent on FCC type acceptance. The Government Contracting Officer shall be furnished a copy of the FCC 'Notice to applicant of type acceptance' letter or postcard, or, if type acceptance is granted by FCC without such written notice, the certification to that effect, dated and signed by a responsible official as a condition for acceptance of the equipment by the Government under the contract.

4.3.5.2 FAA acceptance contingent upon FCC type registration. The Government Contracting Officer shall be furnished a copy of the FCC Form 484 titled "Registration under Part 68", or if registration is granted by FCC without such documentation, the certification to that effect, dated and signed by a responsible official as a condition for acceptance of the equipment by the Government under the contract.

4.3.6 Reliability and/or maintainability demonstration tests. Where required by the contract, life tests and formal reliability and/or maintainability demonstration tests shall be conducted as specifically described in the Reliability/Maintainability Test Plans. Reliability and/or maintainability demonstration tests shall be made on regular production equipment, including those subjected to Type and Production Tests. The Government Contracting Officer shall be notified in writing of readiness for Government Inspection. Such notification shall be given in time to reach the Contracting Officer not less than five working days before the inspection is to start.

4.3.6.1 Preventive maintenance. Preventive maintenance shall be allowed only to the extent as specified in the equipment specification. Preventive maintenance is defined as the scheduled replacement of shortlife items and the scheduled and allowed peaking or tuning that is required to maintain performance within specification limits. It does not include board, module or part replacement predicated on characteristic changes which might lead to failures. These would be classified as corrective maintenance actions.

4.4.2 Basic instrument accuracy. Instruments for measurement of certain basic electrical quantities shall have the rated accuracies specified in Table XII, or better (instrument manufacturer's rating or testing laboratory certification). The percentages given in Table XII for indicating instruments are percentages of full scale. When using analog meters, all readings shall be made within the upper 50 percent of the scale arc.

4.4.2.1 Allowance for less-accurate instruments. As an exception to the requirement for rated accuracies in accordance with Table XII, instruments which are less accurate, up to a limit of twice the percentage values shown in the table may be used, but only for the measurement of an electrical quantity for which a tolerance is specified, and provided that the additional instrument tolerance shall be subtracted from the tolerance specified for the electrical quantity.

4.4.3 Resistance measuring equipment. For measurement of resistors having a rated accuracy of ± 2 percent or better (also to measure resistors of lesser accuracy to resolve questions where tolerances are apparently exceeded by a small margin), and for measurement of transformer and other parts windings for determination of temperature rise by the rise-in-resistance method, digital multimeters having ohmeter accuracy of $\pm 0.1\%$ or better shall be used.

4.4.4 Temperature indicators. Temperature indicating equipment shall have an accuracy of $\pm 2^{\circ}C$ or better.

4.4.5 Humidity measurement accuracy. The techniques used to measure relative humidity shall provide readings within five percentage points of true relative humidity.

4.4.6 Instrument accuracy for other measurements. Instruments for the measurement of quantities other than those specified in paragraphs 4.4.2 to 4.4.3 shall have actual calibrated accuracies greater by a factor of three (as a minimum) with reference to the tolerance specified for each quantity.

4.5 Certification of JAN/MIL type parts and materials. The Federal Aviation Administration does not normally make source inspection of JAN/MIL type parts and materials used in electronic equipment being manufacutured under FAA contracts. In order to provide the Government with evidence that parts and materials meet the requirements of applicable military specifications, it will

verification purposes. The FAA QRO, upon request, shall be provided copies of invoices covering shipments of items from the suppliers facilities to that of the prime contractor. Each invoice shall contain the vendor's certification that each item furnished meets the requirements of the applicable specification(s) including a valid Military QPL status. This certification must be traceable to the part or material manufacturer's quantitative test data pertaining to the specific part or material.

4.5.2 Certified test data. The FAA QRO, upon request, shall be furnished (paragraph 4.5), certified test data verifying compliance with applicable specifications.

4.6 Availability of applicable documents. A complete set of the applicable documents specifications, publications, and drawings, except those issued by FAA for the equipment being furnished on the contract, shall be made available for reference use by the FAA QRO.

4.7 Inspection of design and production status. Upon request from the Government, the contractor shall make available for review at his plant, at any stage of the contract, all information regarding the design and production status of the equipment being manufactured under the contract. Such information shall be available at the plant regardless of point of manufacture of the individual components. The contractor shall provide, for retention by the Government, two copies of each schematic and logic diagram on all electronic assemblies. The schematics shall be those in effect at the time the request is made and all subsequent revisions shall be provided, if requested by the Government.

4.8 AC line frequency. Testing shall be done at an AC line frequency of 60Hz ($\pm$0.5Hz). For specified service conditions requiring line frequencies other than 60Hz, design calculations and equipment part specifications shall be used to demonstrate the ability of the equipment to meet specified requirements. In lieu of the foregoing, the option of testing at all specified line frequencies may be used.

4.9 Barometric pressure. Testing shall be done either at the barometric pressure corresponding to the maximum altitude specified under the service conditions, or at the barometric pressure prevailing at the test site; in the latter case, design calculations and parts specifications shall be used to demonstrate the ability of the equipment to meet performance requirements at the maximum altitude specified under the service conditions.

4.11 Environmental test procedures (service conditions). Design qualification tests and type tests shall be conducted under varying conditions without equipment adjustment (see paragraph 3.3.4), and shall be conducted with the equipment in a thermally-insulated chamber. Uniform ambient temperature throughout the chamber shall be obtained. Means of slowly circulating the air in the chamber may be provided, but violent agitation of the air resulting in rapid circulation through and around the equipment will not be permitted. The chamber shall be equipped with recording devices that will read on detachable material a continuous record of both temperature and humidity. When making the required tests, line voltage variation (paragraph 3.3.4) shall be included. Tests shall be performed with the equipment on and shall be in accordance with the following procedure:

a. Place equipment in chamber under normal test conditions. Make all required tests and record all readings. No further adjustments to controls of equipment under test shall be made during Steps b through h.

b. Reduce temperature to minimum specified (or lower) at any relative humidity.

c. Begin the test at least 15 minutes after the equipment under test has stabilized at a minimum temperature, or lower, as determined by sensors located in the equipment. Finish all tests as rapidly as possible and record readings.

d. Increase temperature to maximum specified for service conditions in 5 hours or less at any relative humidity. Maintain maximum temperature, or higher, for not less than 6 hours. During this process, record all readings approximately each 10°C rise in temperature, but not less than once an hour during the temperature increasing period. During stabilization period, record all readings once an hour with a final reading at end of the period. Where recording times exceed one hour, continuous readings shall be taken.

g. Return chamber to normal test conditions temperature range at any relative humidity less than 80%. Equipment may now be removed from chamber, if specified normal test conditions of ambient temperature exist outside of chamber.

h. After temperature and relative humidity stabilize, allow the equipment to operate for not less than 48 hours under normal test conditions. Record all readings at beginning and end of the 48-hour period.

i. After the complete cycle of tests the equipment shall be examined for indications of rust, corrosion, flaking of plating, deterioration of paint, and deformation of plastic materials, to determine specification compliance.

4.12 Sound pressure test. Equipment requiring sound pressure testing (see paragraphs 3.3.1.3.1 and 3.3.1.3.2) shall be in accordance with the following procedure:

a. The maximum sound pressure levels shall be measured at a distance of 3 ft from the equipment being tested.

b. At least four sets of noise level readings shall be submitted. One set shall have been taken opposite each of the four principal orthogonal surfaces of the equipment. Each octave band reading of each set of readings shall be no greater than the specified value in Table I.

c. Test area data consisting of the test room volume (in cubic feet, in which the noise measurements are conducted) shall be provided. All principal surface areas of the room shall be described in sufficient acoustic detail to permit an estimation of the approximate Room Constant or Room Absorption for the space.

d. During the tests, the equipment shall be in normal operation at not less than 50% full rated load (or at a specified mutually acceptable load condition). The tests shall be carried out by the equipment manufacturer or by a FAA approved testing agency. Whenever possible, approved "standards" of measurements shall apply.

e. In lieu of the tests above, final testing for conformance may be made following complete installation of the equipment at the FAA site,

f. For all noise tests, the ambient noise level of the test area shall be at least 10 dB below the specified levels in Table I. The octave band sound measurement equipment shall meet the applicable ANSI standards for that type of equipment.

5. PREPARATION FOR DELIVERY

5.1 General. Requirements for packaging, packing and marking for shipment shall be as specified in the equipment specification or work statement and will be in accordance with MIL-E-17555.

6. NOTES

6.1 Additional data required. Attention of procurement request initiators is invited to the items listed below which should be covered in the equipment specification or contract schedule:

a. Applicable Design and Test values (see paragraph 3.3.1.5.1).

b. Environmental conditions in which the equipment will be required to operate (see Table III). The considerations for energy efficiency versus performance and costs of equipment. This would also include considerations for the environmental costs of where the equipment is installed (see paragraph 3.3.1.5.2).

c. Requirements for detachable power cord and AC line receptacle (see paragraph 3.3.2.1.4).

d. Requirements if aluminum front panels are mandatory (see paragraph 3.3.3.2.2).

e. Power Source (see paragraph 3.3.2.3).

f. Requirements for test point data (see paragraph 3.3.2.4.6).

g. Requirements for mating cable connectors (see paragraph 3.3.3.1).

h. Reliability requirements and reliability program plan (see paragraph 3.3.5).

4.2).

(1) Requirement for Contractor's Preliminary Tests (see paragraph 4.3.1).

(2) Requirements for Design Qualification Tests (see paragraphs 4.3.2 and 4.11).

(3) Requirements for Type Tests (see paragraphs 4.3.3 and 4.11).

(4) Requirements for Production Tests (see paragraph 4.3.4).

(5) Requirements for Reliability Demonstration Tests (see paragraph 4.3.6).

l. Levels of preservation, packaging, and packing if other than specified herein (see paragraph 5.1).

m. Requirement for parts approval for the Program Parts Selection List (PPSL) (Appendix I).

6.2 Type testing, quantities over 700. For contract quantities over 700, the contract schedule should specify the type test requirements under paragraph 4.3.3.1.

6.3 Provisioning. Provisioning shall be in accordance with FAA-G-1210 and FAA-G-1375. The terms "standard parts" and "nonstandard parts" are as defined in paragraphs 3.5.1.1 and 3.5.1.2 of this specification.

When required by the specification contract or statement of work, the contractor shall prepare a Program Parts Selection List (PPSL) for those applicable parts listed in MIL-STD-965. The number of different part types shall be held to a minimum and the use of standard parts shall be maximized. The PPSL shall be submitted for approval to the FAA in accordance with the contract and as follows:

10.2 General:

a. Standard parts proposed for listing in the PPSL shall be submitted on DD Form 2053, Figure 3.

b. Nonstandard parts approval requests shall be submitted by preparing Part I of a DD Form 2052, Figure 4.

c. Parts contained in off-the-shelf equipment shall not be subjected to this procedure nor listed in the PPSL. When off-the-shelf equipment requires modification, the parts to be used in the modification are subject to this procedure.

d. The contractor shall include contractual coverage in all their subcontracts and subcontractors in all their sub-subcontracts to insure compliance with this Appendix to the same extent as the prime contractor.

e. The respective FAA Washington DC procuring activity shall be the cognizant office over all RFA's and is the FAA focal point for the Parts Control Program in the equipment specification and applicable contract.

f. The FAA's contracting officer or his designated technical representative shall be responsible for final approval and/or disposition of parts requests submitted by its contractors and for all formal contact with contractors.

g. The Military Parts Control Advisory Groups (MPCAGs) located at the Defense Electronics Supply Center (DESC) and the Defense Industrial Supply Center (DISC) are authorized to review and recommend

Commander
Defense Electronics Supply Center
ATTN: DESC-EPA
Dayton, Ohio 45444
Telephone number for general inquiries:
Area Code: (513) 296-5431

Commander
Defense Industrial Supply Center
ATTN: DISC-ESM
Philadelphia, PA 19111
Telephone number for general inquiries
Area Code: (215) 697-3000 or 697-3007

Information on specific parts is available from personnel listed in the MPCAG Director.

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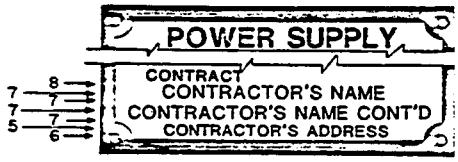
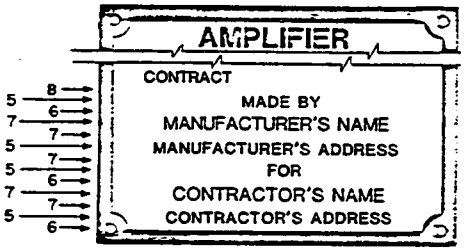
BASIC DESIGN

SINGLE-LINE EQUIPMENT TITLE AND CO
NO SUB-CONTRACTOR



TWO LINES FOR CONTRACTOR

INCREASE HEIGHT OF BASIC DESIGN B



EQUIPMENT MADE BY SUB-CON

INCREASE HEIGHT OF BASIC DESIGN BY

FIGURE 1
FAA DRAWING C-21216

93/94

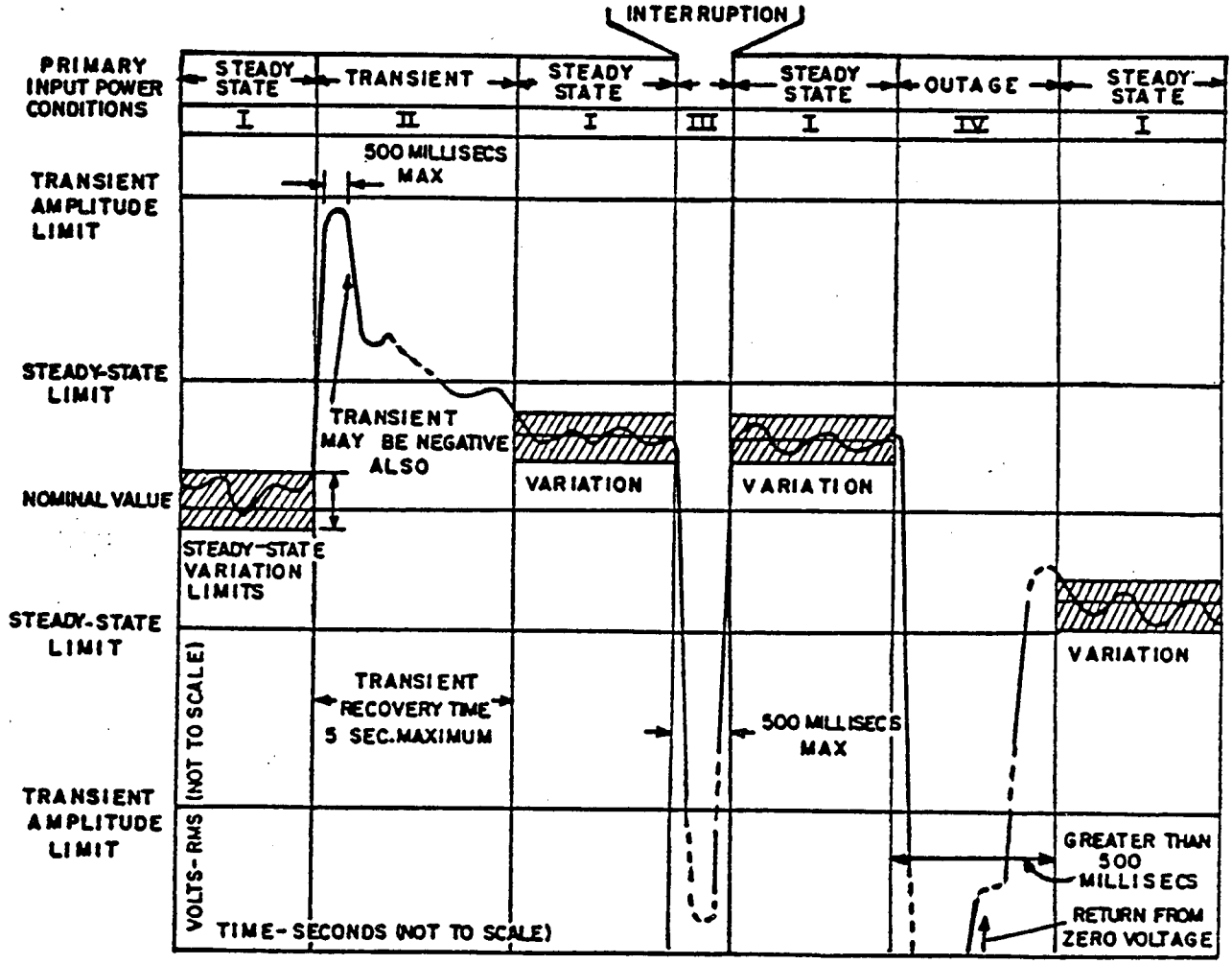


FIGURE 2
EXAMPLES OF A.C. PRIMARY INPUT VOLTAGE CONDITIONS

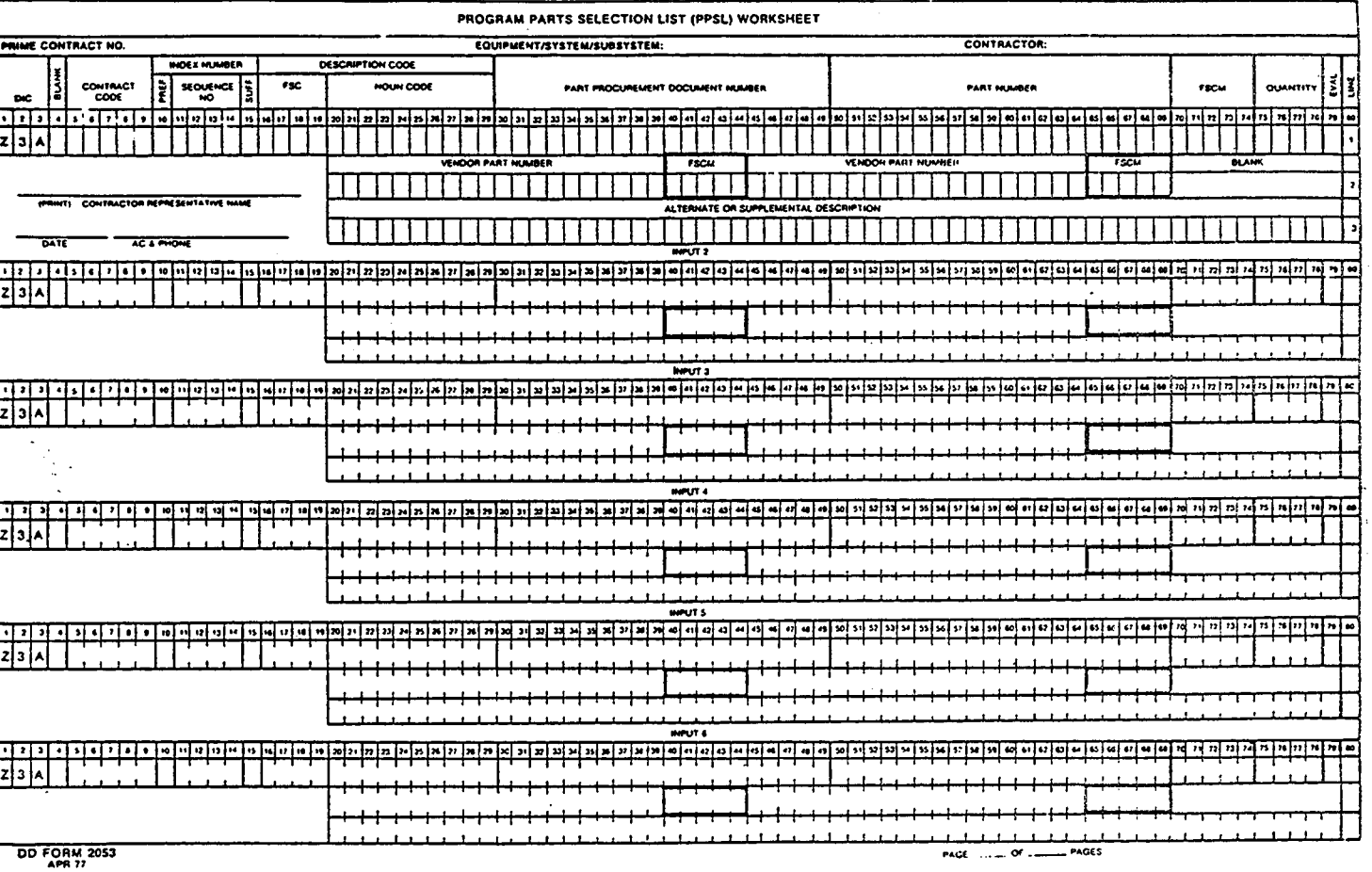


FIGURE 3
DD Form 2053

11. EVALUATION REQUESTED (*"X" appropriate box*) ☐ PART ☐ PART AND DOCUMENT ☐ DOCUMENT ONLY	11A. LOG NO. FOR PART PREVIOUSLY SUBMITTED ON THIS CONTRACT
12. DESCRIPTION CODE	13. ALTERNATE OR SUPPLEMENTAL DESCRIPTION
14. REASON FOR USE OF NONSTANDARD PART *(Compare part with nearest equivalent standard) (Continue on reverse side, if necessary)*	

REPLY NEEDED BY	PRINTED OR TYPED NAME OF CONTRACTOR REPRESENTATIVE	DATE	PHONE NO. *(Include Area Code)*

PART II - RECOMMENDATION

DATE IN	DUE DATE	EVAL. OPI	MPCAG MANAGER	SERVICE ACTY	ENGINEERING ITEM CODE

15. APPROVAL		16. DISAPPROVAL		17. NO RECOMMENDATION		18. DOCUMENT EVALUATION	
	WITHOUT LIMITATION		REPLACE WITH MIL PART *(Complete blks 19A thru D)*		INSUFFICIENT INFORMATION *(See comments, block 23)*		ADEQUATE
	LIMITED APPLICATION *(Complete blks 19A-E or 20A-C)*		SPEC. BEING PREPARED *(Complete blks 19A thru E)*		NOT UNDER THIS REVIEW AGENCY		INADEQUATE *(See comments, block 23)*
	OTHER LIMITATIONS *(See comments, block 23)*		COMMERCIAL REPLACEMENT *(Complete blks 20A thru C)*				NO DOCUMENT

19A. REPLACE WITH *(Enter Mil. Spec., Fed. Spec. or Gov't approved Std)*		20A. REPLACE WITH COMMERCIAL PART/TYPE/STYLE NO.	
19B. MIL PART/TYPE/STYLE NO.	19C. FSCM	20B. MANUFACTURER	20C. FSCM
19D. OPL AVAILABLE ☐ YES ☐ NO ☐ N.A.	19E. DATE MIL SPEC AVAILABLE	21. REPLACEMENT DESCRIPTION CODE *(As applicable to blks 19B or 20A)*	

22. PART RECOMMENDED IN BLOCK 19B OR 20A IS: ☐ INTERCHANGEABLE ☐ SUBSTITUTE ☐ REPLACEMENT

23. COMMENTS *(Continue on reverse side, if necessary)*

EVALUATOR AND DATE	OPL MONITOR AND DATE	ADP INPUT	
		A	
		E	
		F	

PART III - PROCURING ACTIVITY DECISION (*"X" only one box*)

☐ 24A. IMPLEMENT RECOMMENDATION ☐ 24B. APPROVE PART ☐ 24C. DISAPPROVE PART

25. COMMENTS *(Continue on reverse side, if necessary)*

PROCURING ACTIVITY REPRESENTATIVE *(Typed or printed name)*	SIGNATURE OF REPRESENTATIVE	DATE

DD FORM 1 FEB 78 2052 EDITION OF 1 APR 77 MAY BE USED UNTIL EXHAUSTED

FIGURE 4
DD Form 2052

BAND (Hz)	LEVEL (dB re 0.0002 microbar)
31	70
63	66
125	62
250	58
500	54
1000	50
2000	46
4000	43
8000	43

PARAMETER	VALUE	TOLERANCE
Ambient temperature	+30°C	± 10°C
AC line voltage	120 V	± 2 V
	208 V	± 3.5 V
	240 V	± 4 V
AC line frequency	60 Hz	± 0.5 Hz
DC voltage	48 V	± 1 V
	24 V	± 1 V

ment*	(°C)	(%)***	(ft. above sea level)	(mph)	Loading
I	+ 10 to + 50	10 to 80	0 to 10,000	- - -	-
II	- 10 to + 50	5 to 90	0 to 10,000	- - -	-
III	- 50 to + 70**	5 to 100	0 to 10,000	0 to 100	Encased in 1/2" radial thickness clear ice

*I For equipment installed in an attended facility
II For equipment installed in an unattended facility
III For equipment installed outdoors (antennas, field detectors, etc)

** Includes 18°C for solar radiation

*** Above 40°, the relative humidity shall be based upon a dew point of 40°C

AC Voltage (120 V)	102 V to 138 V	** (±1 V)
AC Voltage (208 V)	177 V to 239 V	** (±2 V)
AC Voltage (240 V)	204 V to 276 V	** (±2 V)
AC line frequency (60 Hz)	57 Hz to 63 Hz	** (±0.2 Hz)
DC voltage (48 V)	44 V to 52 V	** (±0.5 V)

** Where discrete values of the above frequency or voltages are specified for testing purposes, the tolerances given in parentheses shall apply to these parameters as they are indicated on the measuring instruments specified in 4.4.

TABLE V

EQUIPMENT PERFORMANCE REQUIREMENTS VERSUS
CONDITION OF A.C. PRIMARY INPUT POWER

	PART A			PART B
Cond	CONDITIONS OF ALTERNATING (AC) PRIMARY INPUT POWER FOR EXAMPLE SEE FIGURE 1		See Note	EQUIPMENT PERFORMANCE REQUIREMENTS
I	Steady-State Condition			
	Voltage Tolerance	±10% of nom.		
	Voltage variation	± 5% of nom. max.	1	Equipment shall deliver and ma specified performance (normal
	Frequency tolerance	± 5% of nominal		
	Frequency variation	± 1% of nom. max.	1	when operating from any probab tion of indicated limits of vo
	Voltage wave form, Deviation factor	10% maximum	2	frequency and waveform.
II	Transient-State Condition			
	Voltage Amplitude, maximum	±30% of nominal, from any point within ±10% steady state tolerance band		Momentary impairmenet of equipr performance during transient pe unless specified performance re individual equipment specificat
	Frequency Amplitude maximum	±10% of nominal, from any point within 5% steady state band		False operational or output sig not be generated.
	Duration of maximum amplitude	500 milliseconds maximum		Damage to equipment or alterati equipment characteristics shall
	Recovery time	5 seconds maximum	3	Automatic resumption of normal upon cessation of transient.

TABLE V (cont)
EQUIPMENT PERFORMANCE REQUIREMENTS VERSUS
CONDITION OF A.C. PRIMARY INPUT POWER

	PART A			PART B
Cond	CONDITIONS OF ALTERNATING (AC) PRIMARY INPUT POWER FOR EXAMPLE SEE FIGURE 1		See Note	EQUIPMENT PERFORMANCE REQUIREMENTS
III	Steady-State Condition			
	Voltage/Frequency	Amplitude excursion greater than maximum transient amplitude	4	Specified performance not n during power interruption. or output signals shall not
	Interruption time	500 milliseconds maximum		Damage to equipment or alte characteristics shall not o
				Automatic resumption of nor end of interruption period individual equipment specif wise fail safe.
IV	Power Outage			
	Voltage/Frequency	a. Power interruption of longer than 500 milli-seconds duration.		Fail-safe. False operational or output not be generated.
		b. Loss of one or more phases of a 3-phase power input		Damage to equipment or alte equipment characteristics sl
				Automatic resumption of nor shortest time period possibl of steady-state power (or re phase power), if required by equipment specification.

NOTES:
1. Variations at any constant load. Vrariations confined to within steady-state tolerance lin
2. Open-circuit voltage, line-to-line and line-to-neutral.
3. For transient-state condition persisting longer than 5 seconds, the equipment response shal under Condition IV (power outage).
4. Includes voltage excursion to zero.

Alumel	AL	Tungsten Rhenium	W RE
Iron	FE	Tungsten	W
Constantan	CN	Iridium	IR
Copper	CU	Rhodium	RH
Platinum	PT	Iridium Rhodium	IR RH
Platinum Rhodium	PT RH	Molybdenum	MO
Rhenium	RE	Gold	AU

To 150	A	1/16	1/16	1/16
	B	1/8	1/8	1/4
	C	1/4	3/8	3/4
150-300	A	1/16	1/16	1/16
	B	1/8	1/8	1/4
	C	1/4	1/2	3/4
300-600	A	1/16	1/8	1/8
	B	1/8	1/4	1/4
	C	1/4	1/2	3/4
300-1000	A	1/8	1/8	1/2
	B	1/4	1/4	1
	C	1/2	1-1/2	2

Notes

1. Condition A is for use where the effect of a short circuit is limited to the unit; and where normal operating power does not exceed 50-watts.

2. Condition B is for use where short circuit protection in the form of fuses, circuit breakers, etc, is provided; and where normal operating power does not exceed 2000 watts.

3. Condition C is for use where short circuit protection in the form of fuses, circuit breakers, etc, is provided; and where normal operating power exceeds 2000 watts.

4. Enclosure I is an equipment enclosure which has no openings or the openings are constructed so drops of liquid or solid particles striking the enclosure (at any angle from 0° to 15°) from the vertical cannot enter the enclosure directly or by striking and running along a horizontal or inwardly inclined surface. ("Drip-proof enclosure excluding motors, generators, and similar machines" meet this description).

5. Enclosure II is any equipment enclosure which requires less protection than Enclosure I.

2 and larger	.200

Acrylics	Polyamide
Acrylonitrile-styrene	Polycarbonate
Acrylonitrile-vinyl-chloride copolymer	Polyester-glass fiber laminates
Asbestos	Polyethylene, high density (above 0.940)
Ceramics	Polyethylene terephtalate
Chlorinated polyether	Polyimide
Flourinated ethylenepropylene copolymer (FEP)	Polymonochlorotrifluoroethylene
Glass	Polypropylene
Metals	Polystyrene
Mica	Polysulfone
Plastic laminates:	Polytetrafluorethylene
Silicone-glass fiber	Polyvinylidene chloride
Phenolic-nylon fiber	Silicone resin
Diallyl phthalate	Siloxane-polyolefine polymer
Polyacrylonitrile	Siloxane-polystyrene

GROUP II
(Not fungus-resistant in all grades;
fungus-resistance shall be established by test)

ABS (acrylonitrile-butadiene-styrene)	Polyethylene, low and medium density (0.940 and below)
Acetal resins	Polymethyl methacrylate
Cellulose acetate	Polyurethane (the ester types are particularly susceptible)
Cellulose acetate butyrate	Polyrichinoleates
Epoxy-glass fiber laminates	Polyvinyl chloride
Epoxy-resin	Polyvinyl chloride-acetate
Lubricants	Polyvinyl fluoride
Melamine-formuladehyde	Rubbers, natural and synthetic
Organic polysulphides	Urea-formaldehyde
Phenol-formaldehyde	
Polydichlorostyrene	

NOTE: Literature shows that under certain conditions polyamides may be attacked by selective micro-organisms.

Specification Requirement	Paragraph No.
Transient Protection	3.3.2.6
Noise levels	3.3.1.3
Interlock bypass switch voltage limitations (at maximum line voltage in service conditions range)	3.3.7.1.6
X-radiation	3.3.7.2
Ground potentials	3.3.7.1
Exhaust air temperature	3.3.3.5.2
AC line controls	3.3.2.1.1
AC line inputs resistance to ground (service conditions of temperature and humidity)	3.3.2.1.3
Transformer isolation, DC power supplies	3.3.2.1.6
Electrical load balance (when applicable)	3.3.2.3.1
Power factor	3.3.2.3.2
Equipment effect on power source (when applicable)	3.3.2.3.3
Equipment response versus condition of primary input power	3.3.4.3
Electromagnetic compatibility	3.3.8
Meter switching: Peak voltage	3.5.5.11.1
Accuracy	3.5.5.11.3
Motor protection, locked rotor	3.5.5.14

Quantity	I	II	III	IV	V	VI	VII	VIII
1-10	1							
11-25	1	2-10						
26-50	1	2-10	11-35					
51-75	1	2-10	11-35	36-60				
76-100	1	2-10	11-35	36-75				
101-150	1	2-10	11-50	51-100				
151-200	1	2-10	11-50	51-100	101-150			
201-300	1	2-10	11-50	51-100	101-150	151-200		
301-500	1	2-10	11-50	51-100	101-200	201-300	301-400	
501-700	1	2-10	11-50	51-100	101-200	201-300	301-400	401-600
701 and up as specified in the procurement document								

(except filament/heater voltage)	± 1.0 percent
Filament/heater voltage	± 0.5 percent
Frequency, AC line (60 Hz)	± 0.5 percent